



ЕВРОПЕЙСКИ СЪЮЗ  
www.eufunds.bg



ПРОГРАМА ЗА  
РАЗВИТИЕ НА  
СЕЛСКИТЕ РАЙОНИ



КОТЕЛ • СУНГУРАРЕ • ВЪРБИЦА  
МЕСТНА ИНИЦИАТИВНА ГРУПА



МИГ  
Поморие

Европейски земеделски фонд за развитие на селските райони: Европа инвестира в селските райони



**ГЕОПАРК ПОМОРИЕ**

СВЪРЗАНА ОБЩНОСТ С ГЕОЛОЖКО НАСЛЕДСТВО

# “ПОМОРИЕ” ГЕОПАРК

Dimitar Sinnyovsky



SOFIA 2025

---

Association for Preservation of the Bulgarian Geodiversity  
European Agricultural Fund for Development of Rural Regions

## **“POMORIE” GEOPARK**

Dimitar Sinnyovsky

Contract № ПД50-4/19.3/У02/01.03.2024. Project № BG06RDNP001-19.607-0010-C01 "ROADS:  
Roads to a sustainable geotourism " in the frame of the administrative contract № ПД50-  
4/10.01.2024 г.

Sofia, 2025

---

## CONTENT

Geopark „Pomorie“ .....	3
1. Concept .....	3
2. Key Geotopes .....	4
2.1. Volcanic rocks .....	4
2.2. Pomorie Lake .....	6
2.3. Marine terraces .....	10
2.4. Old Mouth of Acheloi River .....	13
2.5. Golyama Biberna Peak .....	13
2.6. The alley of Ginkgo .....	16
2.7. Cretaceous/Tertiary Boundary .....	18
2.8. R-1 Golitsa Borehole .....	18
2.9. Beach Terraces and Dunes .....	22
2.10. Mineral waters .....	25
Discussion .....	27
Conclusion .....	29
References .....	30

## „Pomorie“ Geopark

### 1. Concept

The idea of creating the "Pomorie" Geopark arose during the geological survey of the Kableschkovo volcano carried out by Venelin Jelev and Dimitar Sinnyovsky on the day of the 1100th anniversary of the Battle of Acheloi on August 20, 2017. On this date, on Mount Golema Biberna, from where Tsar Simeon I the Great observed the theater of the battle, the idea was born to create a park-type protected area in which historical, cultural and natural heritage of the Pomorie region will be managed through a holistic concept of protection, education, research and global promotion.

This policy is currently implemented by the Local Action Group (LAG Pomorie) under the LEADER+ Programme, whose renovated building is located in the center of the town (Fig. 1-1a). Its qualified staff is working to promote geodiversity in the area by developing a geological heritage database, promotional materials for the general public, and geological exposition at the Pomorie Lake visitor center. (Fig. 1-1b).

According to [Wimbledon et al. \(1995\)](#) the geology of any region can be represented by individual sites of special interest (geotopes). „Pomorie“ The concept of the geopark encompasses two main themes: the Late Cretaceous volcanism and the Quaternary sea level fluctuations that led to the formation of the Pomorie Lagoon and the associated salt mining technology from ancient Anhialo, an intangible cultural heritage of the town of Pomorie, as well as the famous healing bituminous mud. Emblematic of the town are also the Monastery of "St. George" (Fig. 1-1c) and its "ayazmo" with healing mineral water, and the unique in Eastern Europe Salt Museum (Fig. 1-1d).



**Fig. 1-1:** **a**, The renovated building of LAG Pomorie; **b**, The Pomorie Lake Visitor Center, which houses the geological museum; **c**, "St. George" Monastery; **d**, The Salt Museum.

Three volcanic centers have been established on the territory of the Geopark: Dabnik, Kableschkovo and Kamenar, whose products are widely exposed between the village of Bata and the town of Pomorie. They

were formed during the Cretaceous period at the bottom of the Tethys Ocean more than 80 million years ago. Volcanic products have penetrated deeply into the life of the local population: the mineral springs, the panels of the houses, the road surface, the sidewalks, the magnetite sand, the dam of the lake, the piers - everything is from volcanic rocks.

Apart from their practical importance, the Upper Cretaceous volcanics are of exceptional geoheritage value. Here are described two rock types new to science - "bulgarite" and "burgazite" published and confirmed in the petrographic nomenclature by Prof. [Ivan Borisov](#) as early as 1965. The first one is named after the village of Bulgarovo, and the second one- after the city of Burgas.

An important part of the geographical diversity of the region are also the old marine terraces, delineating ancient coastlines of the Black Sea basin: the Nymphaean, the Novochernomorian, the Karangatian, the Old Euxinian and the Chaudinian. Historical roots of salt mining and mud treatment in Pomorie embody the inextricable link between the natural and cultural heritage of the region. The Pomorie lagoon is unique in the Balkans with the balneotherapy properties of its salty waters and anaerobic mud deposits. Its formation is related to the Holocene fluctuations of the sea level, which affect not only the local landscape, but also the ancient civilizations that inhabited the Black Sea coast for several millennia.

The Pomorie Lagoon is part of the Burgas Lakes complex. It is a remarkable Ramsar site of international importance as a waterfowl habitat and part of the Via Pontica wild bird migration route between Europe and Africa. More than 250 species of birds reside in the lake, including rare species such as the saber beak (*Recurvirostra avosetta*), stilt-foot (*Himantopus himantopus*), maned tern (*Sterna sandvicensis*) and exotic species such as the pink flamingo.

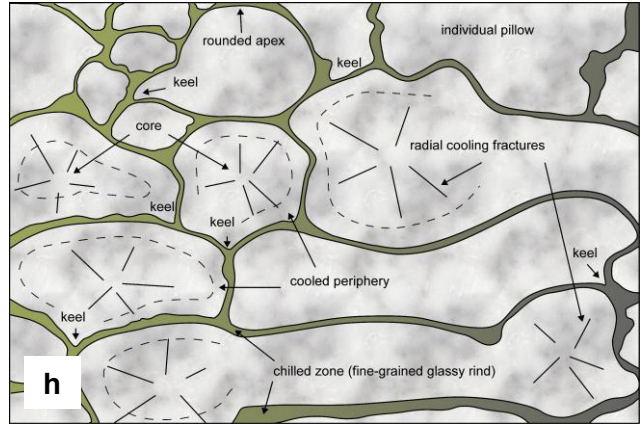
The ancient breakwater of Anhialo, called "Rehata" by the locals, which is now below the modern sea level, is attractive ancient evidence of the rate of subsidence of the seacoast from antiquity to the present day and an extremely relevant example of the connection between human history and geological processes.

Other attractive geotopes are the iridium layer at the Cretaceous/Tertiary boundary, formed by the meteorite impact at the end of the Cretaceous, also known as "the asteroid that killed the dinosaurs", the ginkgo alley in the center of Pomorie, which demonstrates the persistence of the living fossil *Ginkgo biloba* lived over 170 million years, or one of the deepest boreholes in Bulgaria carried out in the area northwest of the village of Kozichino. In the drilling cuttings of this borehole three new to science species of unicellular algae were determined, which are among the first representatives to appear on earth belonging to Order *Coccolithophorida* 215 million years ago.

## 2. Key geotopes

**2.1 Volcanic rocks** are among the most remarkable geological formations in Geopark "Pomorie". The territory of the Geopark is part of the type area of two Bulgarian rock types - bulgarites and burgazites named after the village of Bulgarovo and the city of Burgas. Therefore, some of the most important geotopes are related to the volcanic terrains, which occupy more than half of the territory of the Pomorie municipality.

Volcanism is a remarkable geological phenomenon that is an integral part of the Earth's 4.5-billion-years history. It is caused by the movement of igneous magma from the mantle to the Earth's surface, where it erupts through vents in the Earth's crust called volcanoes. In addition to lava, volcanoes also release huge amounts of poisonous gases and ash into the atmosphere (Fig. 2-1a). Volcanic lava can be subaerial and underwater. Subaerial lava is 'aa', 'pahoehoe' and blocky. The 'aa' lava (Fig. 2-1b) is made up of rough and angular lumps (slags) called clinkers. 'Pahoehoe' lava (Fig. 2-1c) has a smooth, wavy, or rope-like surface, and blocky lava (Fig. 2-1d) is also composed of angular blocks of more viscous lava than the basaltic 'pahoehoe' and 'aa' that often occur together. The widespread underwater lavas, pillow lavas, are of basaltic and andesitic composition. They are oval "tongues" of lava resembling giant pillows measuring 1-2 m (Fig. 2-1e). Upon contact with water, the lava becomes covered with a thick glassy crust (Fig. 2-1f) and continues to swell until it ruptures at a specific location called "keel" and a new pillow begins to form (Fig. 2-1g,h).





**Fig. 2-1:** *a*, Modern hydrothermal activity, volc. Mutnovsky, Kamchatka; *b*, "Aa" lavas, Klyuchevsky volc., Kamchatka (photo I. Demyanchuk); *c*, "Pahoehoe" lava, Plosky Tolbachik volc., Kamchatka; *d*, Blocky lavas, Mutnovsky volc., Kamchatka; *e,f*, Pillow lavas, Trachyte quarry, Bata village; *g,h*, Photo and sketch with pillow lavas terminology, "Trachyte" Quarry, Bata Village; *i*, Bulgarite pillow lavas on burgasite tuffs in Kamenar quarry; *j,k*, Radial jointing in andesites, Kamenar quarry; *l*, Lapilly tuffs, Kamenar quarry.

Bulgarites are composed of potassium-alkaline lava with abnormally high contents of alkaline oxides and aluminum, which makes them unique not only for Bulgaria, but also in the world petrographic practice. They were described and published by prof. [Иван Борисов \(1965\)](#). On the territory of the Pomorie municipality, exceptionally well-preserved and accessible for observation bulgarite pillow lavas are exposed in the quarries near the village of Bata (fig. 2-1e-g) and Kamenar quarter (fig. 2-1i). They were formed at the bottom of the Tethys Ocean during the Late Cretaceous about 80 million years ago. In the andesite lava flows, characteristic radial and vertical jointing is observed (Fig. 2-1j,k). Psammite, lapilli and bombe tuffs are predominant among the burgasite flows (Fig. 2-1l).

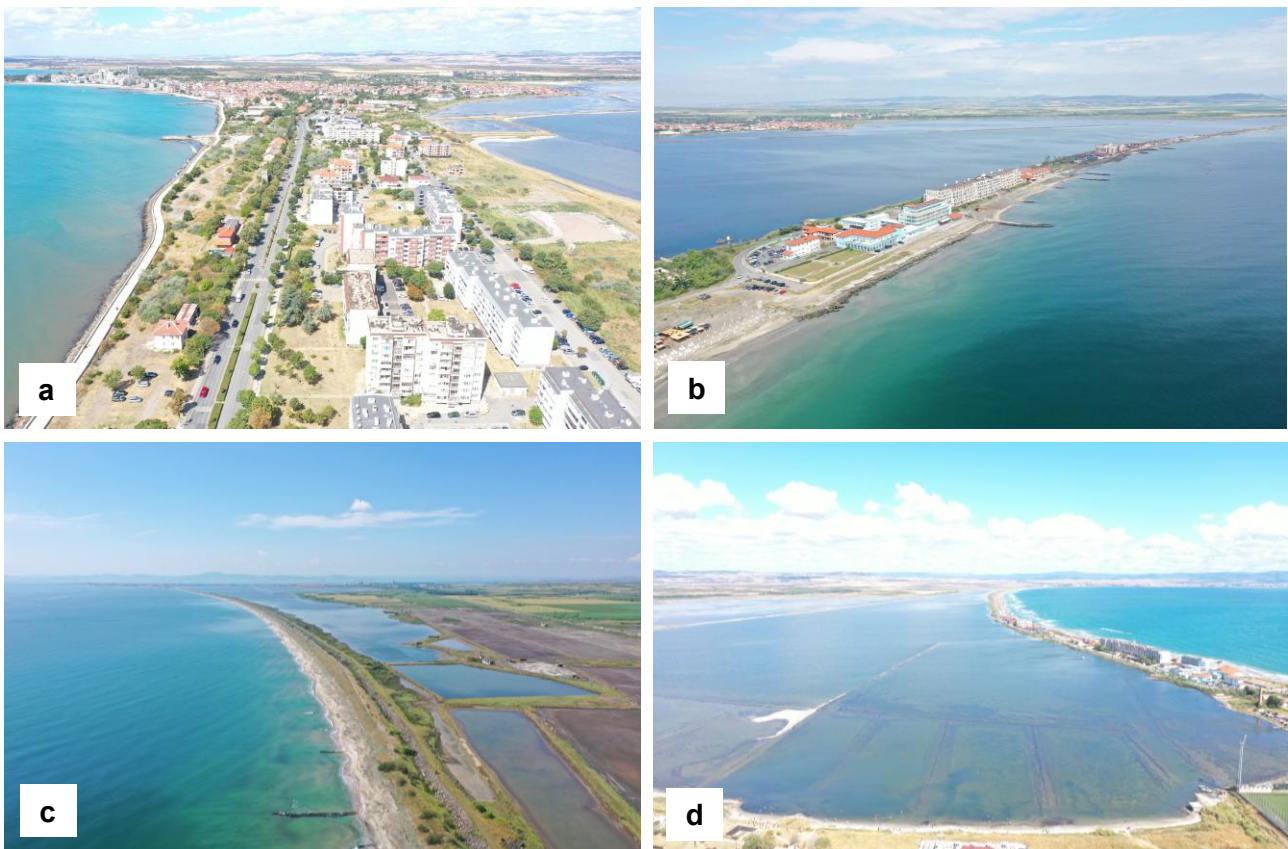
**2.2. Pomorie Lake** is part of the Burgas Lake Complex, which consists of three estuaries - Mandrensko, Burgassko and Atanasovsko Lakes and one lagoon - Pomorie, located parallel to the coast between the towns of Pomorie and Aheloy. It has been declared a Protected Area with the aim of "Protecting Pomorie Lake, the salt pans and the adjacent coastal terrain as a wetland of international importance and as a habitat for 63 species of endangered birds" according to Order 31/23.01.2001, State Gazette No. 16/2001 with an area of 760.83 ha, code 144 in the State Register of Protected Areas. It has been declared a Ramsar site under the Ramsar Convention on the Conservation of Wetlands and Waterbirds and is one of the 10 Bulgarian sites on the Convention's global list, registered with No. 1229. In 2007, it was included in the European ecological network Natura 2000 as a protected area under the EU Birds Directive and a protected area under the EU Habitats Directive.

Pomorie Lake is 6.66 km long, up to 1.69 km wide in the middle and up to 1.6 m deep. Unlike the estuaries, which are drowned river mouths and have a connection with the sea, the lagoon has no natural connection

with the sea basin. However, sea water seeps through the sand bar and replenishes the lake, which evaporates more intensively than the sea. Therefore, the salinity of the lagoon is higher and in summer reaches 60 ppm.

The genesis of the lagoon is associated with a common process accompanying many coastal islands - the formation of a sand tombolo - a sand bar that connects the island to the mainland. The Pomorie Lagoon, however, is a double tombolo (Попов, Мишев, 1974; Канев, 1988), and this is already a rare geological phenomenon. It is difficult to say exactly when it was formed, but it certainly happened after the Novochernomorian transgression (Федоров, 1956), when the sea level was 4-5 m above the current level, and the Old Town was a small island of Sarmatian limestone. About 3000 years ago, it began to fall, and Pomorie Island expanded its area with the drainage of the Novochernomorian terrace, located 4 m above the current sea level, on which the town of Pomorie was built. The island quickly connected to the mainland in the west by a sand bar (Fig. 2-2a).

To the north, another sand bar (Fig. 2-2b) was formed connecting land south of the mouth of the Acheloi River (Fig. 2-2c). Thus, the sand bars formed a double tombolo, cutting off the bay behind the island from the open sea and turning it into a small lagoon (Fig. 2-2d).



**Fig. 2-2:** **a**, The southern tombolo, connecting the old town with the "St. George" quarter; **b**, The Northern tombolo - a 6 km long narrow sandbar between Pomorie and Acheloi; **c**, The northern end of the Pomorie Lagoon, where the northern sand tombolo reaches land almost to the mouth of the Acheloi River; **d**, Pomorie Lagoon.

After decades of research, there is a lot of factual material, the interpretation of which led to the formation of two hypotheses for the transition between the Neoeuxinian and the Black Sea basins, presented in the fundamental collection of articles edited by Yanko-Hombach et al. (2007) "The Black Sea Flood Question".

According to the so-called "Noah's Flood" hypothesis of Ryan & Pitman (1998), Ryan et al. (1997a,b), Ryan (2007) and others, 8400 years ago there was a catastrophic flooding of the freshwater lake from the Ice Age with salty Mediterranean waters, during which the sea level rose from -90 to -30 m within a year. By analogy

with the biblical parable of Noah, this hypothesis seeks rather a spectacular sensation, ignoring decades of research on the Black Sea basin in the last century. Based on abundant scientific data, a number of authors [Acsu \(2002\)](#), [Yanko-Hombach, Tschepaliga \(2003\)](#), [Balabanov \(2007\)](#), [Yanko-Hombach \(2007\)](#), [Kuprin, Sorokin \(2007\)](#), [Сорокин, Куприн \(2007\)](#), [Hiskot et al. \(2007\)](#), [\(Yanko-Hombach et al., 2013\)](#) and many others defend the hypothesis of a gradual and oscillatory sea level rise. They also refer to the rich factual material from drilling and surface studies of the Black Sea shelf by the republics of the former USSR and the countries of the former Eastern Bloc, which are unfortunately ignored in the global scientific debate, apparently due to the language barrier and the lack of scientific dialogue between the West and the East ([Yanko-Hombach, 2007](#)).

Sea level fluctuations during the Holocene epoch have been well studied by several researchers of the Black Sea basin. [Архангелский, Страхов \(1938\)](#) divided the Holocene deposits into “ancient Black Sea” and “modern”, which is called by [Федоров \(1963\)](#) Chernomorian (Black Sea) horizon (stage). [Larchenkov, Kadurin \(2011\)](#) called it the Black Sea transgressive interval with two subintervals – Starochernomorian (Early Black Sea) and Novochernomorian (New Black Sea) (Fig. 2-3a). The Starochernomorian includes the Bugazian and Vityazevian transgressive-regressive stages, and the Novochernomorian includes the Kalamitian and Dzhemetinian transgressive-regressive stages. They were first separated by [Невесская, Невесский \(1961\)](#) as Bugazian, Vityazevian, Kalamitian and Dzhemetinian “layers”. These authors were the first to note that the Black Sea transgression was an “uneven process” with “accelerations and decelerations”.

The Novochernomorian transgression is assessed as an oscillatory process, with stages of sea level rise and stabilization ([Larchenkov, Kadurin, 2011](#)). After the 15th century BC, a stage of cooling and a decrease in sea level by 2-3 m followed, called the Phanagorian regression ([Федоров, 1956](#)). Despite the contradictory data about its existence and duration, the Phanagorian regression is not subject to doubt. Based on the results of archaeological research of the ancient Greek polis Phanagoria on the Taman Peninsula near Crimea, [Блаватский \(1961\)](#) suggests that the sea level at that time was not 2, but 4 m below the modern one. As [Благоволлин, Щеглов \(1968\)](#) noted, the fluctuations of sea level during historical time are beyond doubt and are confirmed by undeniable archaeological evidence in the remains of the Greek colony of Khersones in the Crimean Peninsula. There is also much historical evidence of low sea level during the Hellenistic and Roman eras, when a number of fortified cities and ports were built along the Black Sea coast, parts of which are now 3-4 m under water.

In our country, there is also much evidence of low sea level in antiquity. As early as the 1960s, during various excavations and dredging for the expansion of the channel between Varna Lake and the sea, walls and amphorae from the Hellenistic, Roman and early Byzantine eras were discovered. Underwater archaeological research under the leadership of [Горана Тончева \(1964\)](#) established an old settlement different from Odessos, which existed for almost 10 centuries. It was protected by a 4 m high breakwater, which is 2.5 m under the surface. Underwater breakwaters have also been established at Cape Galata, at Sozopol ([Попов, Мишев 1974](#)) and near Pomorie, where it even has a local name "Rehata".

It is possible that the formation of the Pomorie Lagoon began as early as the Dzhemetinian transgressive-regressive stage, when about 3000 years ago (Bronze Age) the sea level began to fall and the Pomorie Island expanded its area with the drainage of the Novochernomorian terrace. At that time, the Pomorie Lagoon did not yet exist, and the Burgas Lakes were wide bays of the Black Sea. At that time, the higher part of Pomorie town, built of the Sarmatian limestones of the Odartsi Formation, was an island. Such coastal islands are often connected to the mainland by a sand bar. Sometimes sandbars can occur on both sides of the island, forming a double tombolo.

Based on the existing data, at least three scenarios can be assumed for the time and manner of formation of the lake: 1) Formation of the lagoon after the Novochernomorian transgression, which continues to exist to this day; 2) Formation of a lagoon after the Novochernomorian transgression, which dries up during the

---

Phanagorian regression and then forms again during the Nymphaean transgression; 3) Formation of the modern lagoon during the Nymphaean transgression, without a prehistory.

1. During the high sea level during the Novochernomorian transgressive interval, underwater barrier shoals formed on both sides of Pomorie Island, connecting it to the mainland. After the sea retreated, these sandbars rose above sea level and formed a lagoon that exists to this day. The weak side of this version is the existence of the lagoon during the Phanagorian regression (from the 15th century BC to the new era), when the sea level dropped to 3-5 m below the modern one. Then the water of the lake could not be retained on land. In addition, when the sea level dropped after the Novochernomorian transgression, the unconsolidated sands of the two tombolos would also lower their hypsometric level in accordance with the sea level, since they are a consequence of wave activity.

2. The second version includes the first and second stages of the previous scenario, but with drying during the Phanagorian regression. This can be an option only if the sand bars were preserved at that time, which is unlikely. As we noted in the previous version, they follow the sea level and its lowering at a certain point would lead to their destruction.

3. The Pomorie Lake was formed after the onset of the Nymphaean transgression at the beginning of the new era, even before the appearance of the ancient Anchialo.

In support of the second and third versions is the road surface discovered 50 m from the shore at a depth of 1 m, which, according to [Канев \(1988\)](#), is most likely from the ancient road between Anchialo and Messemvria. He explains the movement of the lake shore to the west with the slow subsidence of the land, referring to the map of modern vertical movements of the earth's surface in the National Atlas of the Republic of Bulgaria. This fact shows that before the new era the Pomorie Lagoon did not exist. Then Anchialo did not exist either, so it is more likely that this is the ancient road connecting Apollonia and Messemvria.

According to some authors, the Phanagorian regression occurred between the 15th century BC and the 10th century AD. However, data from the Bulgarian Black Sea coast show that it should have ended much earlier, because the Asparuh Wall near Varna, which was built on the seashore at the end of the 7th century to prevent the seizure of a bridgehead from the sea, is now 600 m from the coast. This means only one thing - the sea level was at least 2 m higher than the current one, i.e. the Nymphaean transgression was already at its peak. The same applies to the Acheloi Battle in 917, after which many of the Byzantine soldiers on their way to Messemvria got bogged down in the swamps around the Achelous River, which is possible only at a higher sea level. These historical facts lead to the conclusion that the Nymphaean transgression began well before the seventh century, probably at the beginning of the new era. This thesis is also supported by the fact that on the shore of Lake Mandra on the Novochernomorian terrace in the third century there were ancient ports - Deultum (Debelt) and Skafida (Dymchevo), and the entry of ships into the lake would not have been possible if the sea level was below the current one.

Thus, the interpretation of the historical facts tips the scales for the formation of the Pomorie Lagoon towards the Nymphaean transgression, i.e. shortly before or shortly after the new era, when the level rose to 2 m above the modern one and the island quickly connected to the mainland through the two sand tombolos: to the west and to the north, which cut off the bay behind Pomorie Island from the open sea and turned it into a small lagoon - the modern Pomorie Lake.

The main geoconservation characteristics of Pomorie Lake are closely related to two human activities practiced in the area since ancient times: the ancient Anchialo technology for salt extraction, which is an enduring cultural heritage, and mud therapy with the healing bituminous mud formed at the bottom of the lake.

The ancient Anchialo technology for salt extraction by evaporation of the super-saline waters of the lake is the main craft in the city of Anchialo, founded in the 2nd century AD. As historians like to say, salt was more expensive than gold.

Healing mud is a natural product formed from organic and inorganic compounds at the bottom of the Pomorie Lagoon after various chemical, biological and microbiological processes. The mud is distinguished by its deep black color, fine structure, high plasticity, alkaline reaction and the smell of hydrogen sulfide. It contains a significant amount of hydrogen sulfide, magnesium, chlorides, calcium, sodium, sulfates, etc. The healing factors affect the body primarily through the nerve-reflex pathway and affect the activation of metabolic processes.

**2.3. Marine terraces** are formed when the sea level remains constant for a longer period (thousands of years), and the sea exerts the coast to continuous abrasion. They are excellent indicators of the level of the Global Ocean through the geological past and showing its high and low levels. Their formation is directly related to the glacial and interglacial ages. During the Ice Ages, sea level is low as water accumulates at the poles in the form of ice caps. Conversely, during interglacial periods, glaciers melt and global sea level rises.

The cyclic freezing and melting of the polar ice caps cause changes in global sea level on the order of tens and hundreds of meters. The terraces formed at high sea levels during the interglacial periods are above the modern sea level, and those formed during the ice ages at low sea levels are below the modern sea level. They are erosional and accumulative. In erosional terraces, marine abrasion "cuts" the bedrock and forms extensive flat surfaces around the coast. Accumulative terraces are also flat surfaces, but they are built of loose sediments, usually in low-lying areas of the seashore – bays, lagoons and estuaries.

Cyclic fluctuations of the global sea-level are due to periodic changes in the parameters of the Earth's orbit, which repeat every 20,000 (precession cycles), 40,000 (ecliptic cycles) and 100,000 (eccentricity cycles) years. They were proved mathematically by the Serbian geophysicist Milutin Milankovitch ([Milanković, 1941](#)). Later, the 400,000 years cycles were added to the frequency band of Milankovitch, which, like the 100,000 cycles, are due to a change in the eccentricity of the earth's orbit.

During the Quaternary, four ice ages are known: Günz, Mindel, Ries, and Würm (Fig. 2-3b), the last of which ended 11,700 years ago. Then began the modern interglacial age, coinciding with the last geological epoch - the Holocene. During the Würm Ice Age, the Black Sea was a fresh-water basin - Neoeuxinian Lake (Fig. 2-3c) fed by fresh water from the ice sheet around the North Pole, which reached as far south as Poland and Ukraine. Then the Pomorie area was tens of kilometers from the coastline, since the sea level of the Black Sea and Mediterranean Sea was 90-100 meters below its present level, and Bosphorus was a land isthmus between Asia and the Balkan Peninsula, through which representatives of *Homo sapiens* migrated to Europe and mixed with the indigenous inhabitants of Europe, the Neanderthals *Homo neanderthalensis*. At that time, a low-level marine terrace formed (Fig. 2-3d,e), which is below sea level today, and north in Scandinavia, glaciers flowing into the ocean formed fjords (Fig. 2-3f).

As the ice sheet around the North Pole began to melt, the Black Sea Basin began to fill with fresh water and flow through the Bosphorus into the Mediterranean Sea, which in turn is filled with ocean water via Gibraltar. Thus, an exchange of fresh and salt water was established through the Bosphorus, which continues to this day.

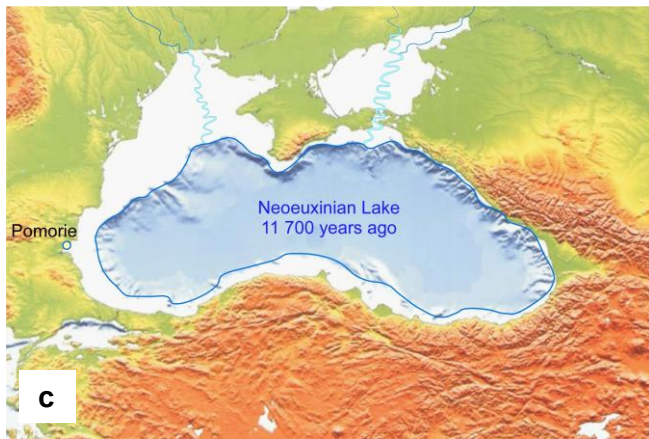
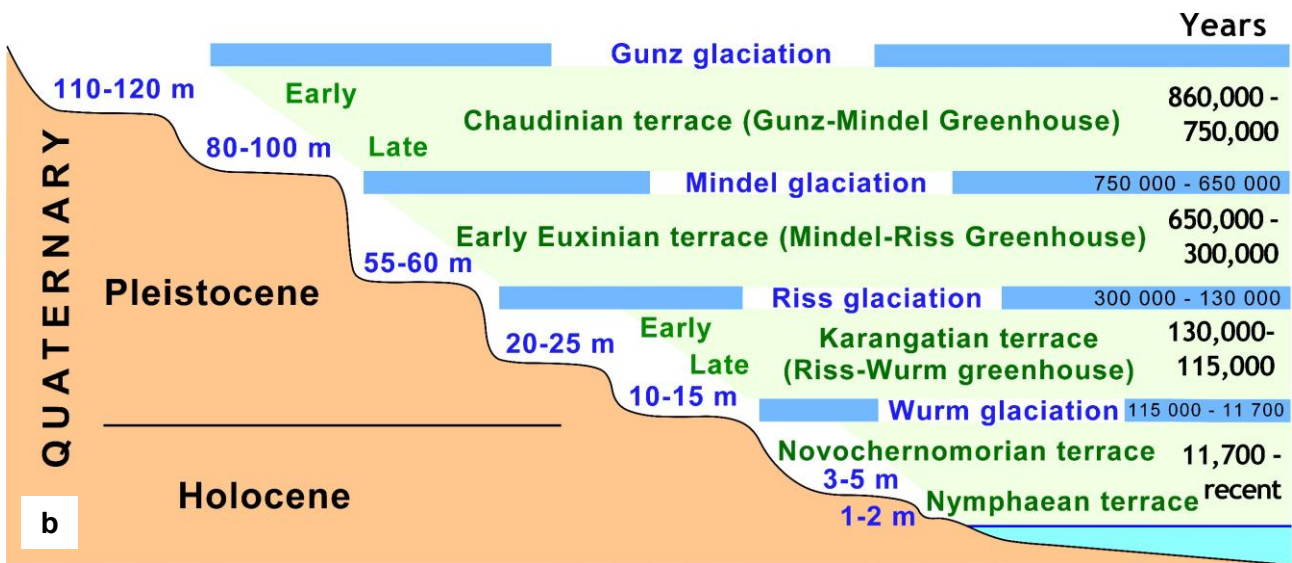
About 8000 years ago the modern sea level was reached, and 6000 years ago it rose to 4-5 meters above the modern one and the Old Town remained an island. Then, during the Novochernomorian transgression ([Федоров, 1956](#)), the terrace was formed, on which the modern town of Pomorie is situated (фиг. 2-3g). Even further back in time during the Riss-Würm Interglacial, 115-130 thousand years ago, the entire peninsula was underwater, as the sea level was 12 meters above the present sea level in tropical climate. Then the Late Karangatian terrace was formed, on which the Old Town is located.

The only place where deposits of an accumulative Novochernomorian terrace are exposed is the old mouth of the Acheloi River, where during the Novochernomorian transgression magnetite sands were accumulated to a height of up to 4 m above modern sea level (Fig. 2-3h). In these deposits alternation of layers with parallel lamination and storm layers with randomly arranged larger particles and shells is available (Fig. 2-3j,k) with a predominance of particles from the volcanic terrains through which the river flows:

trachyandesites, quartz, magnetite, jaspers and even naturally polished agates. Since they are not cemented, they are reworked in the modern beach sand and gravel (Fig. 2-3i,j).

The youngest terrace, the Nymphaean, was formed during the Nymphaean transgression (Федоров, 1959) in the Middle Ages, when the sea level rose to 2 m above the present level. It is associated with global warming after AD, which lasted until the 14th century. Then the so-called "Mini Ice Age" began, which lasted until the middle of the 19th century.

	Transgressive interval	Transgressive-regressive stage	Time (ka)	Depth (m)
<b>Chernomorian</b>	Late Chernomorian (Novochernomorian)	Dzhemetinian	0-4.1	-2 to +2
		Kalamitian	4.1-7.1	-7.5
	Early Chernomorian	Vityazevian	7.1-8.9	10.5-12.5
		Bugazian	8.9-10.0	-25 to -22,5
<b>Neueuxinian</b>	Late Neueuxinian		10.0-18.0	-37 to -35
	Early Neueuxinian		18.0-30.0	-55 to -57





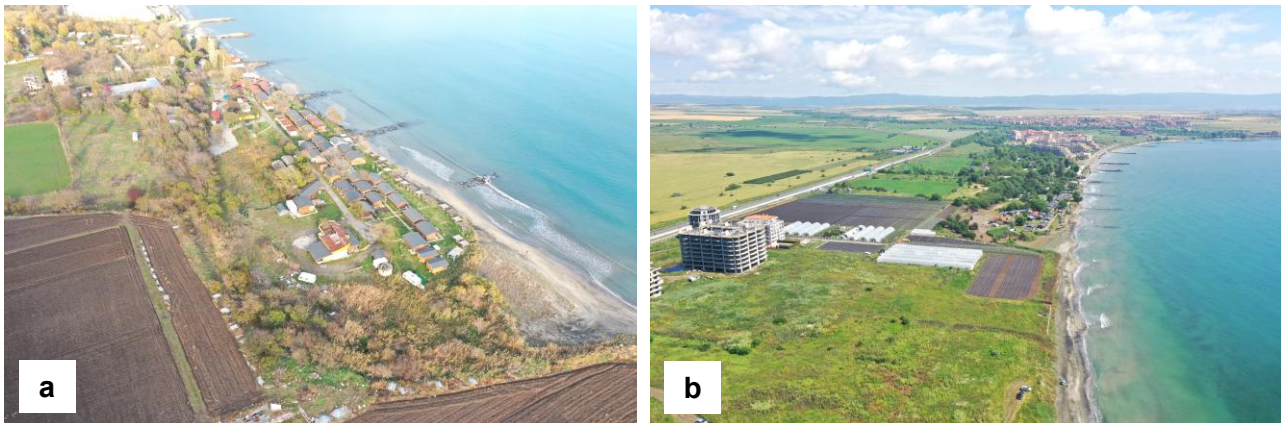
**Fig. 2-3:** *a*, Етапи на Новоевксинския и Черноморския трансгресивен интервал през Холоценската епоха (по Larchenkov, Kadurin, 2011); *b*, Scheme of the Quaternary glacial and interglacial ages; *c*, Area of the Neoeuxinian Basin

at the end of the Würm Ice Age 11700 years ago; **d,e** Low sea level terrace formation during the Würm Ice Age; **f**, Fjord formation during the Würm Ice Age; **g**, Novochernomorian terrace on which Pomorie town is situated; **h**, Accumulative Novochernomorian terrace at the old mouth of Acheloi River in front of Wave Resort; **i**, Alternation of layers with parallel lamination and storm layers among the sands of the Novochernomorian terrace; **j**, Polymictic gravel redeposited in the modern beach from the Novochernomorian terrace; **k**, Rounded particles of trachyandesites, quartz, magnetite, jasper, and even naturally polished agates transported by Acheloi River from the volcanic terrains through which it flows; **l**, Accumulative Nymphaean terrace south of Sarafovo quarter – magnetite beach sand 2 m above the modern sea level.

Within the Geopark, an accumulative Nymphaean terrace is preserved at “Europe” campsite, south of Pomorie, and on the beach south of Sarafovo quarter (Fig. 2-3l), where 2 m above modern sea level, beach magnetite sands deposited during the high sea level in the Middle Ages are exposed. The terrace is also preserved along the western shore of the Pomorie Lagoon, where it is overgrown with reeds.

**2.4. Old Mouth of Acheloi River** existed 4-5000 years ago at the time of the Novochernomorian transgression, when the sea level was 4 m above the modern one. The riverbed is parallel to the seacoast, and its mouth was 1 km south of the present one. It is well-preserved and can be traced to the accumulative Novochernomorian terrace formed by the sediments of the river (Fig. 2-4a,b).

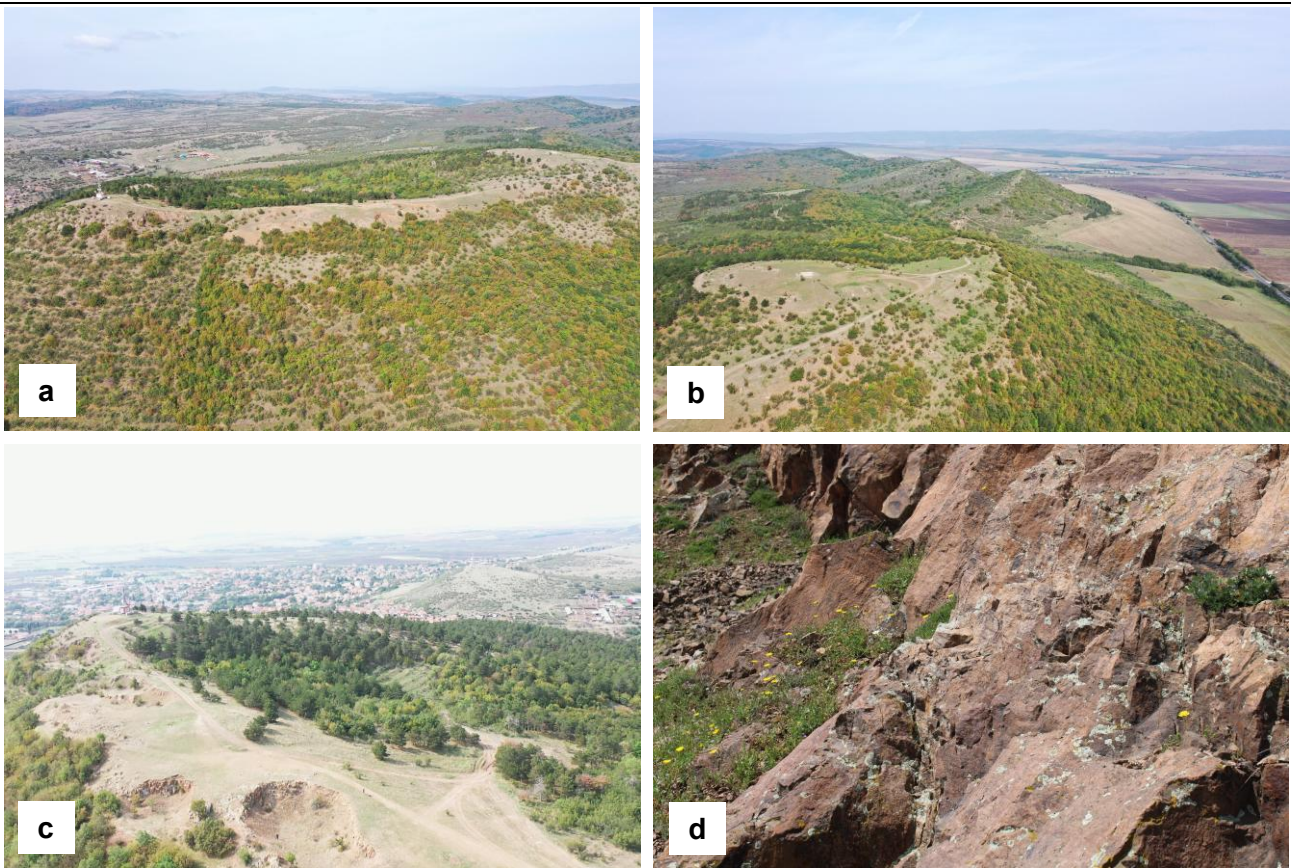
This geotope, in addition to its scientific value, also has high cultural and historical value. The Acheloi River is an emblematic place on the map of Bulgaria, and August 20, 917 is one of the sacred dates in Bulgarian history. Then in this place the troops of Tsar Simeon I the Great defeated the Byzantine army, and he proclaimed himself Vasilevs of Bulgarians and Romans.



**Fig. 2-4:** **a**, The old riverbed of Acheloi River - the forest strip between the farmland and the campsite “Anastassia”; **b**, The Novochernomorian terrace south of Acheloi.

The Acheloi battle remains in history as the apotheosis of the Golden Age, during which the Bulgarians acquired writing and religion, and the Bulgarian state was established as a medieval empire. In addition to the historical facts about the Acheloi battle, the medieval sources also contain indirect data about the geological setting at that time: many of Byzantines perished in the swamps near the Acheloi River during their retreat to Mesembria. This means that the level of the Black Sea was at least 2 m above the present level and is probably the only written confirmation of the Nymphaean transgression in the Middle Ages.

**2.5. Golyama Biberna Peak** north of the town of Kableschkovo is also a geotope with scientific and cultural-historical value (fig. 2-5a). It is located in the northern periphery of the caldera of the Kableschkovo volcano (Fig. 2-5b) and unites several small quarries with outcrops of nepheline trachyte (Fig. 2-5c,d). According to historical sources, from this place Tzar Simeon I the Great observed the theater of the Acheloi Battle on August 20, 917. Exactly 1100 years later, on August 20, 2017, during the geological survey of the Kableschkovo volcano conducted by Venelin Zhelev and Dimitar Sinnyovsky, the idea was born to create a protected park-type area in which historical, cultural and natural heritage will be managed within a holistic concept of protection, education, scientific research and global promotion.

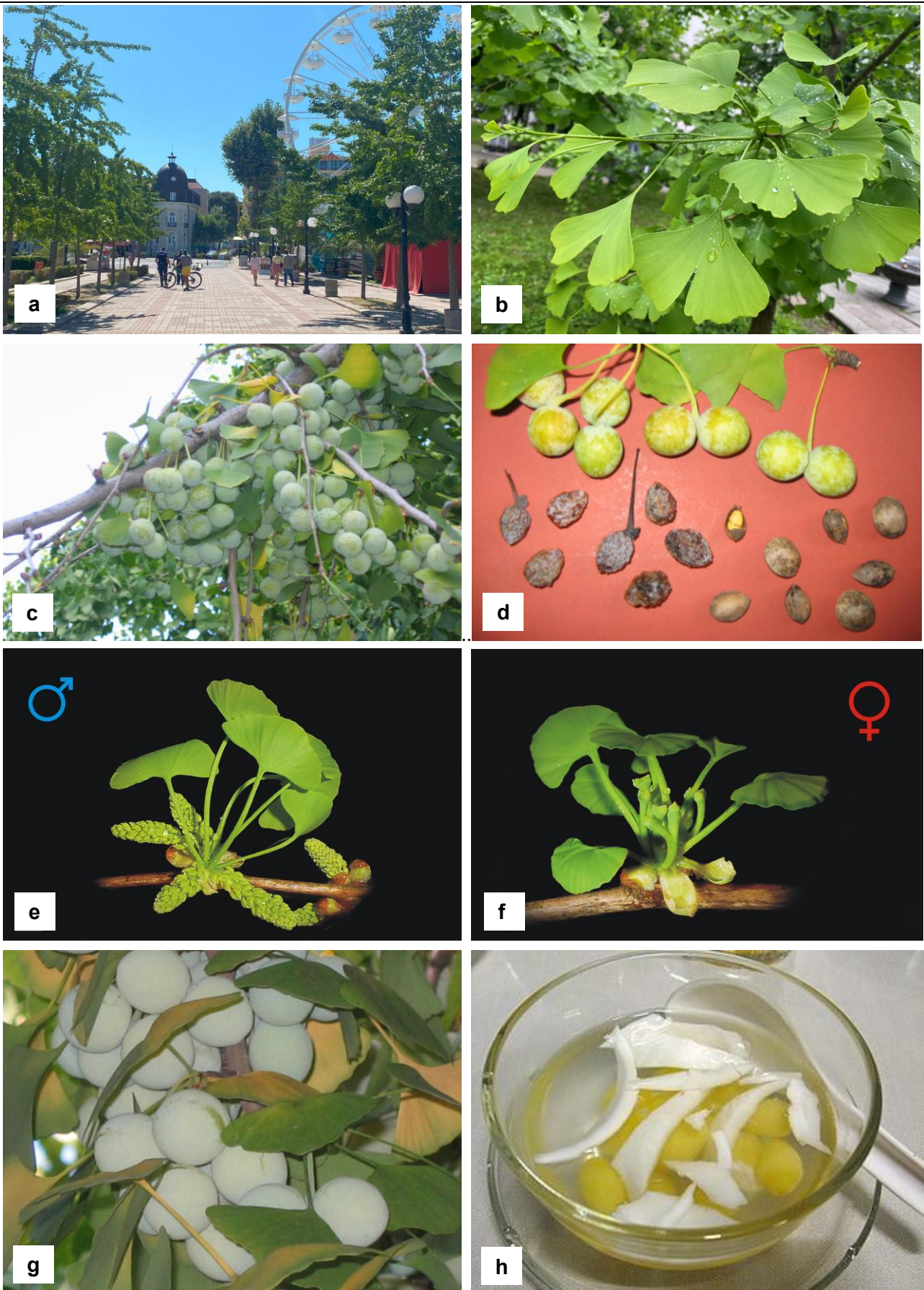


**Fig. 2-5:** **a**, View from the north towards the caldera of the Kableschkovo volcano and the Golyama Biberna peak, from where Tzar Simeon I the Great watched the theater of the Acheloi Battle on August 20, 917; **b**, Sivribair and the northern caldera rim; **c**, The small quarries in the nepheline trachyte on the ridge of Golema Biberna peak, north of Kableschkovo; **d**, Outcrop of nepheline trachyte in a quarry on the Golema Biberna peak.

Based on the features of the lava rocks and geophysical structures with increased density in depth, [Желев](#) (in [Желев, Синьовски, 2024](#)) defines two new paleovolcano centers - Kableschkovo and Kamenar. The "Golyama Biberna" geotope is located on the highest northeastern periphery of the caldera of the newly nominated Kableschkovo volcanic center.

The nepheline trachytes that make up Golyama Biberna peak are part of the lava rocks of the Draganovo Formation, a product of the Kableschkovo paleovolcano. They cut through lapilli and bomb tuffs of the Medovo Formation with burgazite debris, as well as silty-psammitic and lapilli tuffs, cut by quartz-carbonate veins, which are exposed on the southern slope of the peak. From the elevation, a wonderful view opens to the west-northwest towards Sivribair - the northern periphery of the caldera of the Kableschkovo volcano (Fig. 2-5b).

**The alley of Ginkgo** in the center of the town of Pomorie (fig. 2-6a) is a unique opportunity to demonstrate one of the most interesting trees on earth, which appeared more than 170 million years ago. *Ginkgo biloba* is a modern tree species recognized as a living fossil. Living fossils are taxa that resemble related species known only as fossils. In evolutionary biology, living fossils are considered species that meet criteria such as a long range compared to similar forms, slow evolutionary changes, similarity to a fossil ancestor, low taxonomic diversity compared to the past, etc. ([Lidgard, Love, 2021](#)). It is the last of the Order *Ginkgoales* that appeared 300 million years ago during the Permian period of the Paleozoic. Fossil leaves of the species are known from the Middle Jurassic. *Ginkgo biloba* was first described by the famous Swedish biologist Carl Linnaeus in 1771. The specific epithet biloba (bi-lobus) comes from the Latin "two-lobed", because of the shape of the leaves (Fig. 2-6b), but more likely refers to the "fruits" which are always two on one stalk (Figs. 2-6c,d).



**Fig. 2-6:** **a**, Ginkgo Alley in the center of Pomorie; **b**, The forked leaf petiole of *Ginkgo biloba*; **c,d**, Seeds two per stalk; **e**, Male cones with sporophylls; **f**, female seed buds; **g**, The seeds and leaves are used medicinally, and the “nuts” have a hazelnut’s flavor; **h**, Thai ginkgo and coconut dessert.

*Ginkgo biloba* is a deciduous dioecious plant. Male trees form small cones with sporophylls, with two microsporangia each (Fig. 2-6e). Females produce two ovules (Figs. 2-6f) which, after wind pollination, develop into fruit-like seeds whose fleshy casing decomposes with a vomit-like odor to repel seedeaters. This invention turns out to be an evolutionary failure compared to the tasty fruits of flowering plants, which attract animals to disperse their seeds. This is probably also the reason for its disappearance in the wild at the end of the Holocene. However, it has provided it with exceptional geological resistance from the Jurassic to the present day, which no forest tree possesses. It was widespread in the Northern Hemisphere, but by the end of the Cenozoic it was restricted to East Asia. Due to its medicinal properties, it was cultivated in the gardens of ancient Chinese emperors, and thanks to its long-life cycle of 1500-2000, it was preserved until the Middle Ages, when people planted it on other continents.

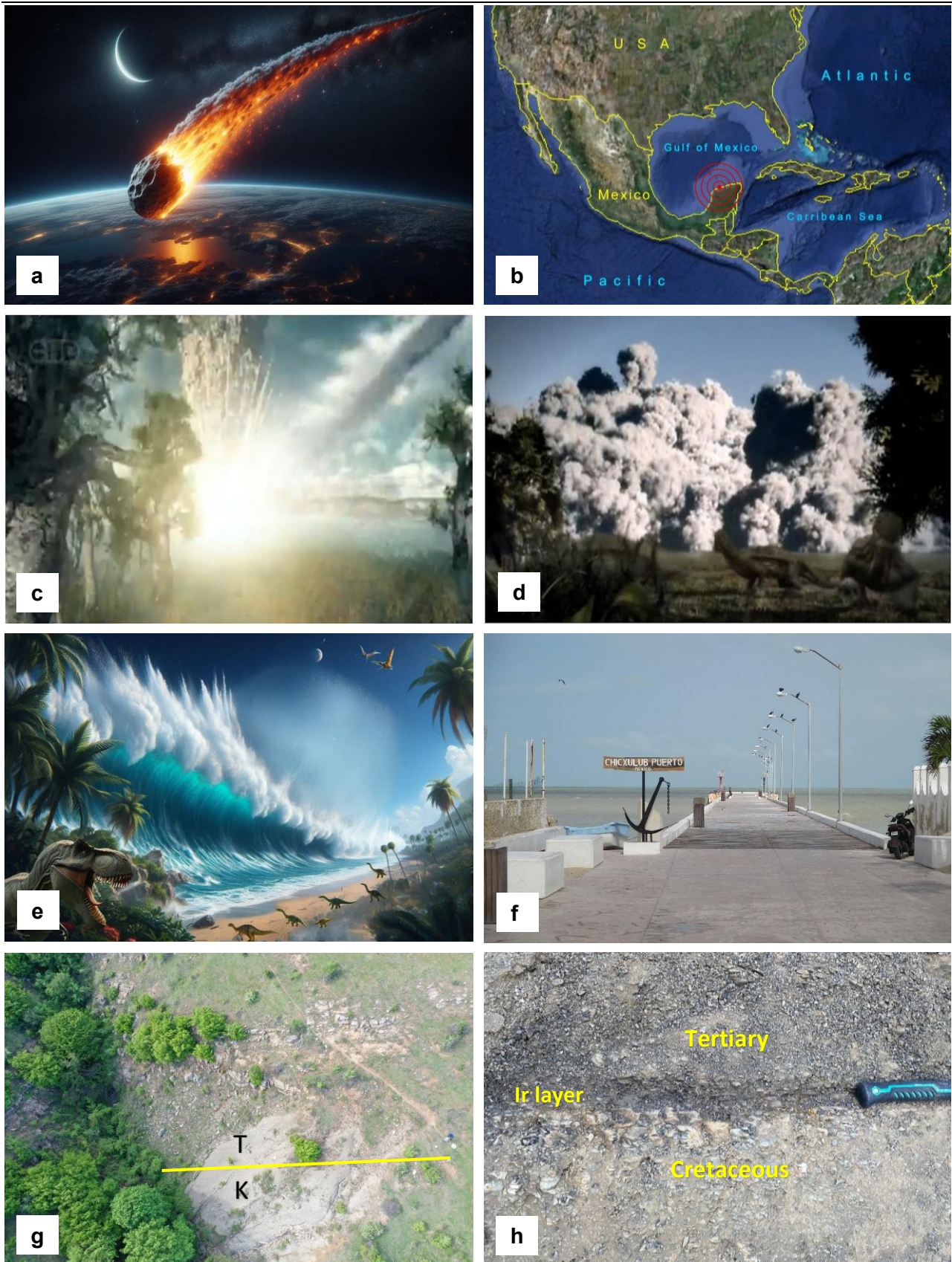
Thus, *Ginkgo biloba* remains for now the only proven species saved for nature by man. *Ginkgo biloba* seeds and leaves (Fig. 2-6g) have been used in traditional Chinese medicine since ancient times. The nuts are also edible with taste like hazelnuts. Ginkgo dishes are served on special occasions such as Chinese New Year. They are also used as a delicacy in Asian cuisine (Fig. 2-6h). Ginkgo's incredible history has inspired extensive research into its iconic role as a geographic relic, with countless fossil analyses, morphological and molecular studies.

**2.6. Cretaceous/Tertiary boundary** near the village of Kozichino is a geotope associated with a global event: a thin iridium layer formed after the great disaster at the end of the Mesozoic era. Then the Earth was hit by a space body known as the "Chicxulub meteorite" or "the meteorite that killed the dinosaurs". Near the village of Kozichino, the iridium layer was discovered in 2002 under the project of the Ministry of Environment and Waters to compile a Register and Cadastre of geological phenomena in Bulgaria.

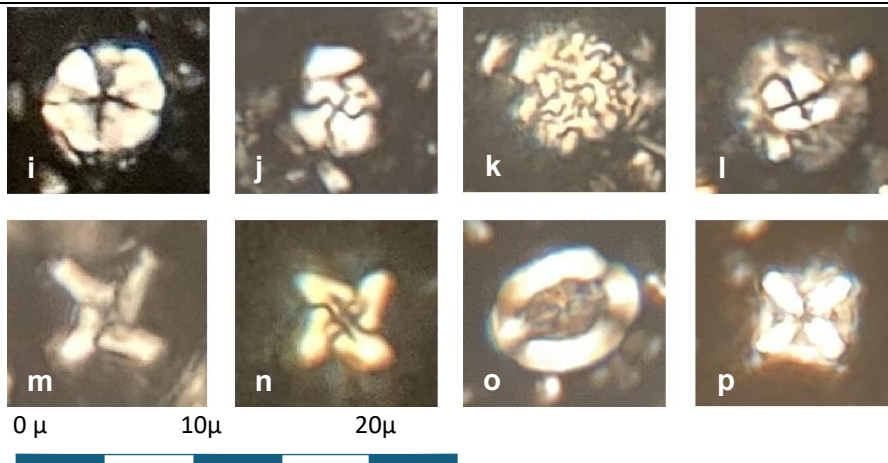
This event occurred 65 million years ago at the end of the Cretaceous period of the Mesozoic Era, when a giant meteorite approached Earth at 40,000 miles per hour (Fig. 2-7a). It passes through the atmosphere and, heated to melting, hits the Earth's surface near the Yucatan Peninsula (Fig. 2-7b), causing the greatest catastrophe in the history of the planet. The meteorite disappeared within seconds into the Earth's crust, and immediately after impact a cloud of heated dust, ash, and steam erupted back out of the crater, rising into the stratosphere (Fig. 2-7c). Then a rain of molten rock (tektites) started to fall down from the sky, causing global fires. A giant shock wave caused by the impact spread across the Earth's surface (Fig. 2-7d), and a powerful megatsunami penetrated hundreds of kilometers inland (Fig. 2-7e).

Confirmation of this story occurred at the end of the 1970s, when the American geophysicist Glenn Penfield discovered a large ancient crater next to the Yucatan Peninsula with a diameter of 180 km. Astrophysicists suggested that the diameter of an asteroid that caused such a crater was at least 10 km. At first glance, that's not much for a space body, but placed next to the Himalayas it would be higher than Everest. Nobel Laureate Luis Alvarez suggested that this is the crater of the meteorite that hit the earth at the end of the Cretaceous. [Alvarez et al. \(1980\)](#) discovered a thin layer at the Cretaceous-Tertiary boundary with a high content of iridium, which is very rare in the Earth's crust but occurs in meteorites. Thus, science unraveled the cause of the mass extinction at the end of the Cretaceous, when entire groups of organisms such as dinosaurs, pterosaurs, marine reptiles, ammonites, belemnites and many unicellular animals disappeared forever, and the meteorite was named after the small Mexican town of Chicxulub, where landed 65 million years ago (Fig. 2-7f).

The explosion in the collision exceeds 10,000 times the potential of all modern nuclear weapons. The vast amount of dusty material that envelops the entire globe blocks out the sun for years. This leads to a change in climate and photosynthetic regime, affecting over 90% of unicellular planktonic flora and fauna, 60% of angiosperms and many groups of echinoids, corals, thermophilic mollusks and primitive mammals. The most vulnerable were unicellular golden algae (coccoliths) which are at the beginning of the food chain.



**Fig. 2-7:** **a**, At the end of the Cretaceous, 65 million years ago, a giant meteorite entered the Earth's atmosphere and landed in the Gulf of Mexico; **b**, The place of the meteorite landing near Yucatan peninsula in Mexico; **c**, After the impact, a cloud of superheated dust, ash, and steam erupted back from the crater, rising into the stratosphere; **d**, The impact caused a giant shock wave that spread across the globe; **e**, A powerful megatsunami penetrated hundreds of kilometers inland; **f**, Chicxulub town in Mexico; **g**, Location of the geotope south of Kozichino village; **h**, Close-up of the iridium layer;



**Fig. 2-7 continuation:** *i*, *Biantholithus sparsus* Bramlette & Martini; *j*, *Cyclagelosphaera alta* Perch-Nielsen; *k*, *Thoracosphaera operculata* Bramlette & Martini; *l*, *Markalius inversus* (Deflandre) Bramlette & Martini; *m*, *Micula prinsii* Perch-Nielsen; *n*, *Micula murus* (Martini) Bukry; *o*, *Arkhangelskiella maastrichtiana* Burnett; *p*, *Micula staurophora* (Gardet).

Ultimately, this global ash fallout formed a thin, dark iridium-rich layer on the ocean floor. The content of iridium in the earth's crust is negligible, since the iridium and its similar elements are concentrated in the earth's core. However, it is present in normal amounts in meteorites. Its presence in the Cretaceous/Tertiary boundary layer proves the cosmic origin of this catastrophe. Microscopic coccoliths, whose major change coincides with the Cretaceous-Tertiary boundary, are a perfect tool for identifying the iridium layer under a microscope with centimeter-level accuracy.

Besides iridium, the boundary layer contains other evidence of the event: shock quartz, microtektites and rare minerals. Shock quartz is often found in rocks around meteorite craters. It is so called because the high pressure of the impact causes its crystal structure to deform along the crystallographic surfaces within the crystal. Microscopic quartz particles spread along with the dust cloud across the globe and are deposited on the bottom of the seas and oceans in the boundary iridium layer.

It contains also microtektites - molten microscopic glass spherules distributed worldwide with the cloud of heated dust particles ejected into the stratosphere after the impact and iridium-rich micrometeorites accompanying the main meteorite body. The section in which the iridium layer was found on the territory of "Pomorie" Geopark is located SW of the village of Kozichino among fine-grained turbidites of the Emine Flysch Formation (Fig. 2-7g,h). It is 4 cm thick and well distinguishable from the underlying marl. The host rock is a dark, low-carbonate, coccolith-poor marl.

The abrupt change in the nannofossil composition occurs at the base of this layer, when the explosion has already taken place and the sedimentation of the ash material from the giant cloud enveloping the entire globe has already begun. In the iridium layer and above it, rare redeposited Cretaceous species are encountered, as well as the first representatives of the Paleogene nannofossils *Cyclagelosphaera alta* Perch-Nielsen and *Biantholithus sparsus* Bramlette & Martini. This interval is characterized by the predominant presence of *Thoracosphaera operculata* Bramlette & Martini, which survived the great catastrophe and occupied the ecological niche vacated by the Cretaceous species. Other survivors such as *Markalius inversus* (Deflandre in Deflandre & Fert) Bramlette & Martini and *Cyclagelosphaera reinhardtii* (Perch-Nielsen) Romein are also found.

**2.7. R-1 Golitsa borehole.** In 2007, just 7 km NW from the village of Kozichino, the deepest borehole in Bulgaria for its time was drilled, penetrating Paleogene, Cretaceous and Jurassic rocks, which are repeated in the section due to their overthrusting along the surface of "Wonderful Walls" dislocation. Beneath the Jurassic rocks almost the entire Triassic System was penetrated with a top depth of 4,600 m in the red Lower Triassic conglomerates and sandstones belonging to the famous continental Buntsandstein facies. The lithological column of the P-1 Golitsa borehole (Fig. 2-8a,b) was made by Yavor Stefanov and dated by calcareous nannofossils by Dimitar Sinnyovsky from mud samples taken every 10 m from 0 to 3400 m and every 5 m to the maximum depth of 4600 m.

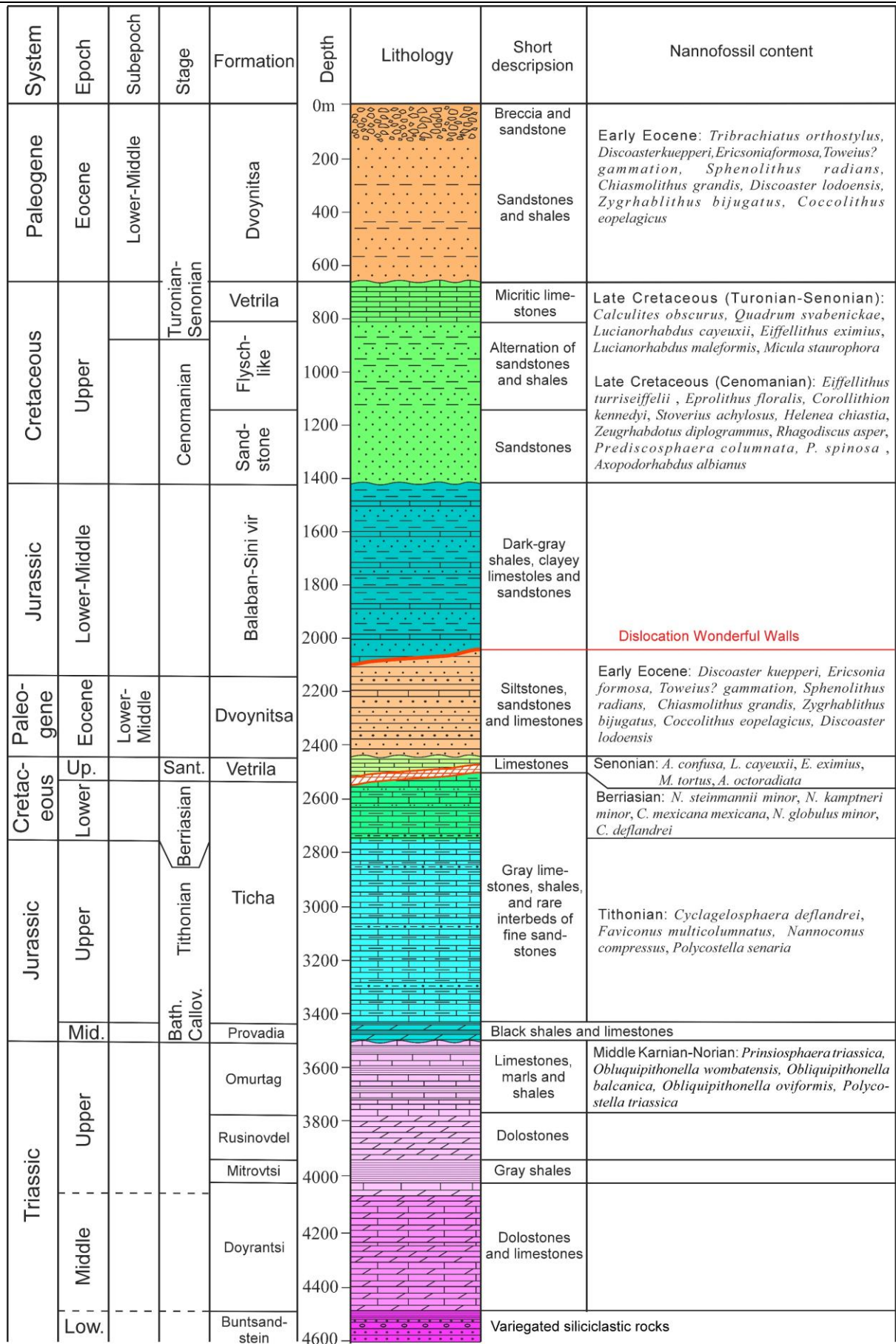
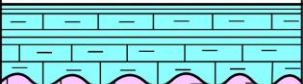
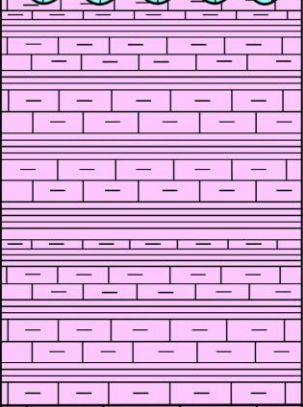
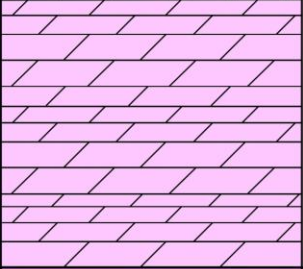
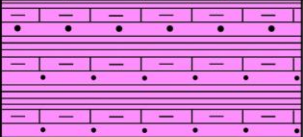
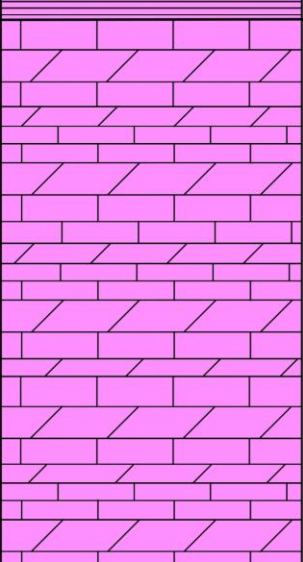
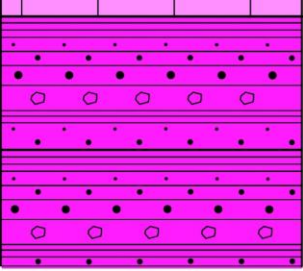
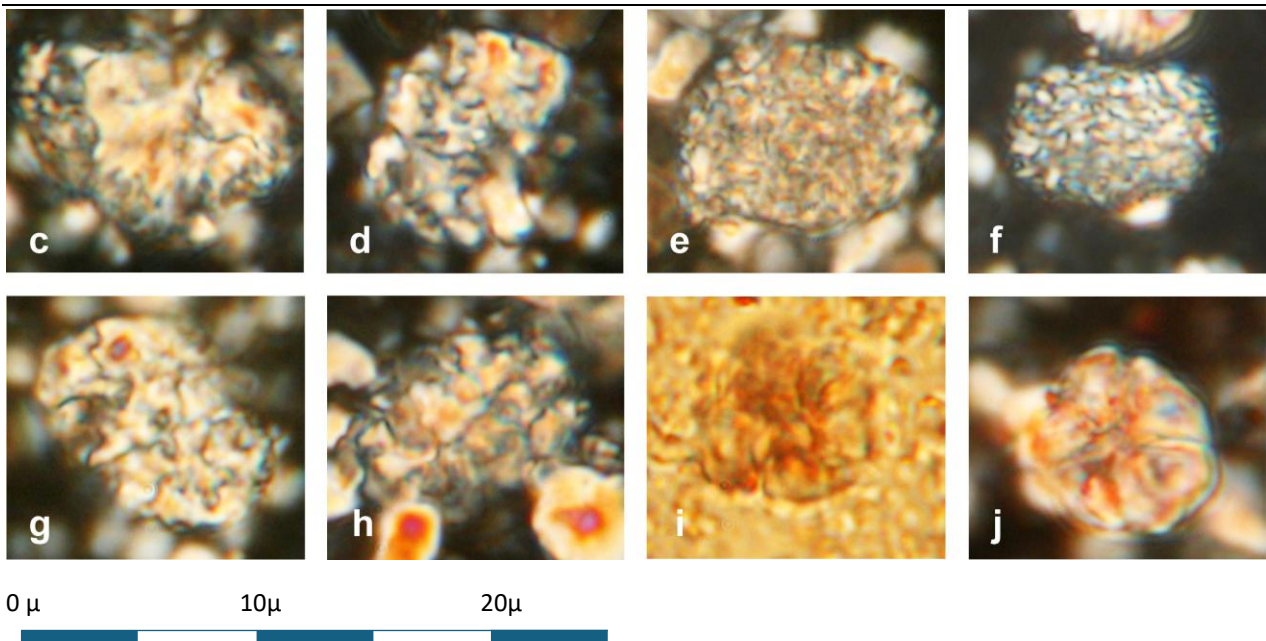


Fig. 2-8a. Section of the penetrated interval of 4600 m in R-1 Golitsa borehole in the East Balkan, samples of which are stored in the geological museum of the Pomorie Lake Visitor Center in the town of Pomorie

Lithostrat. unit	Age	Depth	Lithological column	Lithological characteristics
Ticha and Provadia Fms	Upper Jurassic	3478 m		
Omurtag Fm	Upper Triassic Middle Carnian-Norian	3478-3700 m		<p>Alternation of reddish, greenish and gray limestones, clayey limestones, silty limestones and calcareous shales</p> <p><i>Prinsiosphaera triassica</i> Jafar, 1983</p> <p><i>Obliquipithonella wombatensis</i> (Brallower et al.) Sinnyovsky, 2016</p> <p><i>Obliquipithonella balcanica</i> Sinnyovsky, 2016</p> <p><i>Obliquipithonella oviformis</i> Sinnyovsky, 2016</p> <p><i>Polycostella triassica</i> Sinnyovsky, 2016</p>
Rusinovdel Fm	Upper Triassic (Middle Carnian)	3700-3900 m		Predominantly dolostones, (dolomicrites) and limy dolostones
Mitrovtsi Fm	Mid.-Up. Triassic- Upper Ladinian- Lower Carnian	3900-3950 m		Black shales, fine-grained sandstones and clayey limestones
Doirantci Fm	Lower-Middle Triassic- Olenikian-Lower Ladinian	3980-4550 m		Limestones and dolostones. Most likely, presence of reservoir rocks in the uppermost part (shoals and algal bioherms)
	Lower Triassic Buntsandstein	4550-4600 m		Variagated siliciclastic rocks
		TD 4600 m		

**Fig. 2-8b.** Section of the Triassic interval from 3478 to 4600 m in R-1 Golitsa borehole in the East Balkans, with Omurtag limestones in the upper part in which the new species of Triassic nannofossils are described



**Fig. 2-8: c-j.** Microphotographs of Late Triassic nanofossils from the Omurtag Formation (Magnification  $\times 1250$ ).  
**c,d** *Prinsiosphaera triassica* Jafar, 1983, *X-nicols*; a-3645 m, b-3495 m.  
**e**, *Obluquipithonella wombatensis* (Brallower et al., 1991) Sinnyovsky 2016, *X-nicols*, 3580 m.  
**f**, *Obluquipithonella balcanica* Sinnyovsky 2016, *X-nicols*, 3520 m.  
**g,h** *Obluquipithonella oviformis* Sinnyovsky 2016, *X-nicols*, e-3495 m; f-3655 m.  
**i,j** *Polycostella triassica* Sinnyovsky 2016, g, normal light; h, *X-nicols*, 3495 m.

Calcareous nanofossils are fragments of unicellular golden algae that exist from Late Triassic to present. In the Upper Triassic interval composed of limestones and marls belonging to the Omurtag Formation, five species were determined (Fig. 2-8b-l) including one new combination *Obluquipithonella wombatensis* (Brallower et al., 1991) Sinnyovsky 2016 (Fig. 2-8d), and three species new to science, which are among the first algae of this order to appear on earth: *Obluquipithonella balcanica* Sinnyovsky 2016 (Fig. 2-8d), *Obluquipithonella oviformis* Sinnyovsky 2016 (Fig. 2-8f,g) and *Polycostella triassica* Sinnyovsky 2016 (Fig. 2-8h,i). They are published in the international WEB directory Nannotax (<https://www.ucl.ac.uk/earth-sciences/research/micropalaeontology/research/nannotax>) which is a prestigious reference book on the biodiversity and taxonomy of coccolithophores in which all new taxa of unicellular representatives of Order *Coccolithophoridae* are published. The discovery of new species among the first representatives of these photosynthetic unicellular organisms, which appeared in the Triassic seas about 230 million years ago, is extremely important for science, as they are at the beginning of the food chain.

Coccolithophores are microscopic unicellular algae that inhabit the uppermost photic layer of ocean water at a depth up to 50 m. After completing their life cycle of several weeks, they settle down and form carbonate mud, which, when consolidated, turn into chalk. They have left a deep mark on post-Triassic history of the Earth. During the Late Cretaceous between 90 and 65 million years ago, a great transgression took place over vast areas of the continents in the Northern Hemisphere, which led to a significant increase in the platform seas, and they acquired unprecedented prosperity. After completing their life cycle, which lasts several weeks, they settle down to the bottom and form calcareous mud, which, after lithification through diagenesis, turns into chalk. During the Late Cretaceous on the territory of Northern Europe a thick succession of chalk was formed, which is also widespread in Northern Bulgaria. It is a soft, porous variety of limestone made up of microscopic calcite plates (coccoliths) measuring 5-10  $\mu\text{m}$  which cover the cells of coccolithophores.

The first representatives of these unicellular algae in the Late Triassic are very rare and their preservation in a fossil state is an unusual phenomenon. Due to their older age, Triassic rocks have a higher degree of

lithification than younger Jurassic and Cretaceous rocks, which is why Triassic chalk is rather rare. Triassic limestones recrystallize, and microscopic microfossils fuse with the micrite matrix of the rock, so their identification is a real stroke of luck. Due to the conserving role of the clay component, marls are most favorable for preserving these microscopic remains.

During the lithification of the rocks of the Omurtag Formation, there were obviously suitable conditions for the preservation of some of the first coccolithophores on the planet, and after 220 million years we found them at a depth of 3600 m in the state in which they settled down at the bottom of the Triassic Sea. Rock samples from the entire borehole column (Fig. 18i) are stored in the geological museum in Pomorie Lake Visitor Center in “Pomorie” Geopark, including the samples in which the new species are determined.

Samples from the entire borehole interval are stored in the geological museum of Pomorie Geopark at the Pomorie Lake Visitor Center in the town of Pomorie, including the samples in which the new Triassic species were described.

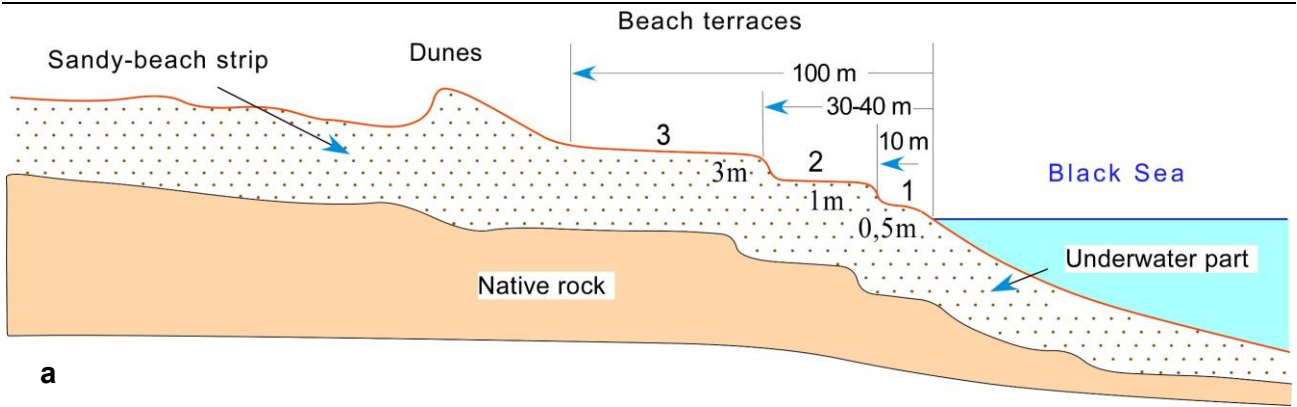
**2.8. Beach terraces and dunes.** The sandy-beach strip is the most widespread accumulation form along the Black Sea coast, which is modeled by wave activity. It consists of an underwater and an above-water part. The destructive activity of sea waves continuously generates sand made up of fragments of bedrock and crushed shells of marine mollusks, which makes the beach an inexhaustible source of sand. The underwater part covers the sand deposits at a depth of up to 10-15 m - the lower limit of the active surf, where the surf waves originate. The surface part is also formed by these waves, which penetrate hundreds of meters inland. It covers the sands from the coastline to the maximum range of storm waves in the direction of land.

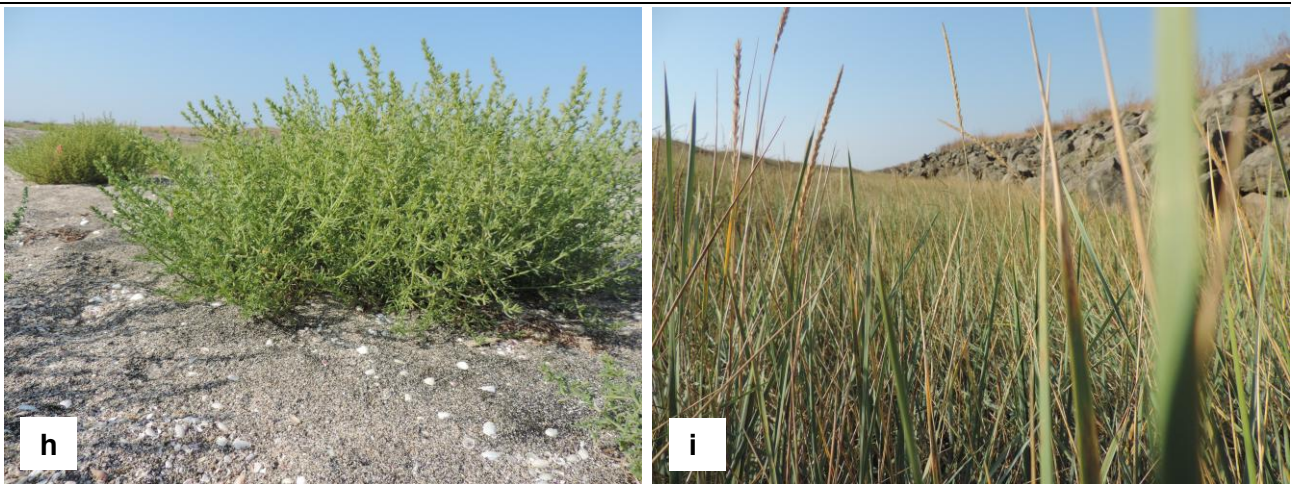
Based on their many years of observations in the coastal part of the sandy beach strip, [Попов & Мишев \(1974\)](#) distinguished three clearly distinct beach terraces (Fig. 2-9a), which are also noticeable on the sandy bar between Pomorie Lake and the sea (Fig. 2-9b,c). To varying degrees, they are expressed almost all year round: a low beach terrace (1) with a height of up to 0.5 m above sea level, formed during weak waves (Fig. 2-9c), a medium beach terrace (2) with a height of up to 1 m above sea level, which is formed during stronger waves throughout the year (Fig. 2-9b,c) and a high beach terrace (3) located 2-3 m above sea level, which is formed by storm waves during the autumn-winter period of the year (Fig. 2-9b,g).

Behind the high beach terrace, dunes are often formed by wind activity. Dunes are modern dynamic three-dimensional geological bodies with an unstable shape, size and location. These are sand hills with well-defined ridges, slopes and a characteristic internal structure – cross bedding (Fig. 2-9d). Dune sands are an integral part of the sandy beach strip and give the coastal landscape an exotic look. In many cases, they are part of protected areas – habitats of rare and protected species, Ramsar sites, managed and biosphere reserves, the protection of which in most cases is based precisely by their presence.

The predominant NE winds play a major role in dune formation in Pomorie, but well-formed dunes are only found on the Central Beach (Fig. 2-9e), as there are favorable conditions for the wind to blow sand from the beach inland. This is the reason why dunes are missing on the southern beach, which is protected from the wind by the Pomorie Peninsula. (Fig. 2-9f). There are no dunes also on the sandbar between the lagoon and the sea, although it is open to the northeast. The sand hills with plant tufts on the Pomorie sandbar (Fig. 2-9g), often called dunes ([Pomorie Lake, 2013](#)), are not dunes because during the autumn-winter period of the year it is flooded by storm waves and the sand drifts along it are regularly destroyed. This was noted by [Канев \(1988\)](#) according to whom “*during a storm, sea waves tear the sand spit of the lagoon and enter the lake*”. Evidence of this is the whole mussel shells carried on them by storm waves.

The surface area of the sandy beach strip is of variable size. Its width is constantly changing due to the intensity of the sea waves and sea currents. Often, after a storm, a large part of the beach sand is “swallowed” by the sea, as a result of which the area of the beach strip is reduced literally in a matter of days. However, this process is two-way, because soon or later these sands are pushed back onto the beach, and the beach strip is restored or even expanded towards the sea.





**Fig. 2-9:** *a*, Cross-section and characteristic elements of the sand-bar strip: 1-low beach terrace, 2-middle beach terrace, 3-higher beach terrace; *b*, Middle (2) and higher (3) beach terraces of the northern tombolo - the sandbar between the lake and the sea; *c*, Low (1) and middle (2) beach terrace of the northern tombolo – the sandbar between the lake and the sea; *d*, Dune terminology; *e*, Dunes on Central beach in Pomorie; *f*, The sandy-beach strip of the South beach is without dunes; *g*, This is what the "dunes" on the sandbar between the lake and the sea look like after a winter storm. *h*, The glasswort (*Salicornia*) is a common succulent species on the higher beach terrace of the sand strip; *i*, Sand ammophyla (*Ammophyla arenaria*) together with common reed quickly suffocate the remaining drought-loving vegetation on the sand strip towards the lagoon.

It is not necessary to read thick volumes to get an idea of the dynamics of modern processes and phenomena on the sandy-beach strip. If you do not live near the sea and do not have direct observations, it is enough to get acquainted with the popular scientific works of [Popov and Mishev \(1974\)](#) or [Kanev \(1988\)](#), in which they are explained in a language accessible to the general public. The connection of natural phenomena along the sandy beach strip with "global warming" and "sea level rise" ([Baltakova, 2023](#)) is in the realm of scientific speculation.

Storm surges are generated by large-scale atmospheric systems characterized by low pressure and strong, sustained winds. When a storm approaches from the sea, it mobilizes a huge amount of water that can penetrate deep into the land and cause serious flooding, as in 2007, when the water reached the Kuban Hotel in Sunny Beach. Conversely, if the storm is in the direction of the sea, it can lead to a temporary drop in sea level, like low tide, which occurred on the Southern Black Sea coast on September 18, 2022.

Dunes are natural landmarks, but not all sands are dunes, and not all dunes are subject to protection. Thus, Sahara would be the largest geopark in the world. Since they are composed of loose sand, they easily degrade and lose their geoconservation value. When compiling the Specialized Map of the Black Sea Coast in our country, the vicious practice of identifying dunes by the so-called "dune habitats" was introduced - a term for places with drought-resistant plants. However, these plants vegetate not only on dunes, but on all kinds of sands, therefore such places should be called "sand" habitats, not "dune" habitats, and should not be used to identify geological formations such as dunes, because this contradicts elementary human logic.

The term "habitat" means an area with a specific combination of environmental conditions inhabited by a population of a given species. The term "dune habitats" is used by biologists to characterize biotopes that include arid plants. They are inhabited by rare and endangered species, but at the same time they are also territories for practicing certain human activities such as salt mining, mud therapy, spa and coastal tourism, which are an important part not only of the livelihood of the local population, but also an important item of the national budget. From this point of view, opposing "nature conservation" activities to the traditional livelihood of the local population are of no use to anyone, especially when the protection of natural sites is based on untenable arguments such as: "the sands are dunes because succulent grasses grow on them".

UNESCO's Man and the Biosphere Programme, which brings together the natural and social sciences, economics and education to ensure the sustenance of mankind and the protection of natural ecosystems, promotes the development of biosphere reserves - territories including terrestrial, marine and coastal

ecosystems. Contrary to the widespread belief that these areas are intended only for the protection of rare and endangered species in an environment completely isolated from anthropogenic activity, biosphere reserves are created to promote the reconciliation of biological diversity with its sustainable use.

The essence of the biosphere reserve coincides with a multifunctional area, including part of the human living space and the living space of other living beings (plants and animals). Its true purpose is to serve for the implementation of different approaches for interaction between social and ecological systems and for the practical implementation of good practices in over 700 reserves in 120 countries around the world. The philosophy of biospheres is that animals and plants should not be isolated from human activities, because this contradicts the principles of biological evolution, which is based on adaptation to the environment. Through it, organisms carry out the mutations necessary for their survival, which are the driving force of evolution. They are the basis of the struggle for existence, in which the winners are the quickly adapting organisms, not the conservative and specialized forms. In this sense, efforts to conserve protected species by encapsulating them in their private habitat do them a disservice, weakening their adaptability. Such creatures, isolated from a dynamically changing environment, are doomed by evolution to extinction.

The so-called "dune habitats" are characterized by xerophytic plants growing on sands. In general, xerophytic plants survive in an arid environment in steppe, semi-desert and desert areas, where the development of other vegetation is unthinkable, but they are also found in normal conditions, and it is more correct to call them drought tolerant. These are highly specialized plants, found not only on sand or dunes, but also in any type of arid environment. For example, the glasswort (*Salicornia*) (Fig.2-9h) grows on saline soils in addition to salty sands. In this sense, the term "dune habitats" has no geological meaning and is in no way a criterion for determining geological formations. It also has no ecological meaning, since a biotope defined on the basis of drought-tolerant plants does not include only the protected ones, but also all other species, some of which can change the landscape beyond recognition. For example, the invasive sand ammobila - *Ammophila arenaria* (Linnaeus) Link (Fig. 2-9i) together with common reed in a few years covered a large part of the sands on the western slope of the sandbar and suffocated the other drought-tolerant vegetation.

Identifying dunes based on sand phytocoenoses is as logical as defining phytocoenoses by the type of rocks they grow on. Such an approach leads to the declaration of protected areas under the Biodiversity Act, but with geological arguments. In addition to contradicting all logic, this also creates unnecessary problems in the use of the coastal beach strip for practicing the traditional livelihood of the local population. To avoid such misunderstandings, served to the general public as "scientific" information in visitor centers, websites and social networks, the identification of dunes should be based on their geological attributes, not on hybrid geo-biological phrases such as "white dunes", "gray dunes", "emerging dunes", etc., freely used by specialists without geological education in protected area management plans, expert reports of ministries and websites of various "nature conservation" organizations. The free use of such phrases changes the meaning of this purely geological term and confuses people's ideas about the value of dunes as geological phenomena.

## 2.9. Mineral waters

The volcanic terrain is a prerequisite for the presence of mineral waters, which reach the surface in the form of dozens of mineral springs and artificial wells. The most popular of them are east of the town of Kableskovo, west of the village of Medovo and the wells around the Kamenar district. They have alkaline mineralization, characteristic of the rocks from which they spring.

The mineral spring in the village of Kamenar "Borehole No. B-53" (Fig. 2-10a,b) was designated as exclusive state property by Act No. 152/14.04.1997 and approved as an exploitation resource by Order RD 703/10.09.2014. It is 247.8 m deep and was built in 1971 as a rectangular reinforced concrete chamber with a discharge pipe for water filling outside the catchment.

The mineral spring west of the village of Medovo "Borehole No. B-72" (Fig. 2-10c,d) was designated as exclusive state property by Act No. 1611/08.08.2011 and approved as an exploitation resource by Order RD 483/02.08.2018. It is 253 m deep and was built in 1976-77 as a rectangular reinforced concrete shaft with a discharge pipe for water filling outside the catchment.

Since Bulgaria is the country with the most thermal springs in the world after Japan and Iceland, special attention is paid to the geothermal characteristics of each of the Bulgarian Geoparks. The high spa potential, used by people since the Roman age, is a leading topic in a number of regions of Bulgaria, including the Burgas region. Pomorie Municipality is no exception to this rule. The oldest mineral spring “Ayazmoto” is located in the courtyard of the monastery “St. George the Victorious” which is housed in a special tower (Fig. 2-10e) and is part of the spiritual heritage of the region. The mineral waters are also used for balneological purposes as in the tourist spa complex “Old Houses” at the foot of the Kableshkovo volcano (Fig. 2-10f).



**Fig. 2-10:** *a,b*, Минералният извор „Сондаж № Б-53“ в кв. Каменар; *c,d*, Минералният извор „Сондаж № Б-72“ западно от с. Медово; *e*, The “Ayazmoto” in the courtyard of the “St. George the Victorious” monastery in the town of Pomorie, whose healing mineral water is associated with medieval legends; *f*, The tourist spa complex “Old Houses” at the foot of the Kableshkovo volcano.

---

## Discussion

According to the Statutes of the International Geosciences and Geoparks Programme, *“Education at all levels is at the heart of the UNESCO Global Geoparks concept. From university researchers to local community groups, UNESCO Global Geoparks promote awareness of the history of the planet as recorded in rocks, landscapes and ongoing geological processes”* (UNESCO General Conference, 2015). Until the Statutes was created, there was a tacit belief among the evaluators of the Global Geoparks Network that the main priority of geoparks is interpretation. However, interpretation is a tool, while education is a mission that includes all tools for disseminating geological knowledge to the general public.

Pomorje Lake is a great place to demonstrate the links between climate and the environment within a permanent educational programme for students and adults. Responsible dissemination of knowledge about climate change in the geological past and present is one of the main tasks of Geopark. To the extent that the formation of the double tombolo is related to the manifestation of global climate changes in the geological past, possible cultural and educational significance can be sought in clarifying the causes and indicators of global warming as a geological phenomenon.

Geological processes and phenomena can be gradual (continuous), which occur in time intervals that are difficult for humans to perceive – hundreds of thousands and millions of years, such as sea level fluctuations, and sudden (catastrophic) with a duration of seconds or minutes, such as meteorite impacts, volcanic eruptions and earthquakes.

Many phenomena lasting from hundreds to tens of thousands of years have a cyclic manifestation. Among them are global climate changes, causing glacial and interglacial periods, which are due to astronomical causes established by the Serbian geophysicist Milutin Milankovitch (Milanković, 1941).

The shortest temperature changes due to the rotation of the Earth around the Sun are diurnal and annual. The shortest geological changes, however, last hundreds of years and although they are short-lived in a geological sense, they do not fit into human concepts of short-termism and are incomparable with human life. Therefore, it is not correct to scare people with apocalyptic predictions about the imminent sinking of coastal cities as a result of global warming, which is a geological process. Such predictions come from people without geological education, who cannot imagine the immense duration of geological processes over time.

It is widely known that the best lie is half the truth. Based on mass measurements of temperatures from stations in different regions of the world, “scientific” models are constantly being created that predict an apocalyptic picture by the end of the century: shrinking glaciers, powerful cyclones, prolonged droughts, submerged cities, destroyed crops, fires, floods, deforestation, misery and famine. Speculating on strictly scientific facts, such as the ratio of greenhouse gases in the atmosphere, most of these models do not include the huge contribution to the absorption of CO<sub>2</sub> by the oceans but concentrate on the industrial release of heat-trapping greenhouse gases into the atmosphere, which has a negligible contribution to the concentration of CO<sub>2</sub> in the atmosphere.

An emanation of this paranoid theater is the film “An Inconvenient Truth” directed by Davis Guggenheim and wrote by the former vice-president of the USA Albert Gore (Guggenheim & Gore, 2006), which received exceptional international recognition, incl. Oscar for Best Documentary in 2007. It contains many half-truths, presented with the artistic techniques of modern cinema in a way that convinces people that all modern troubles come from the greenhouse effect caused by the increasing concentration of CO<sub>2</sub> in the atmosphere as a result of human activity. Geological processes are viewed through the prism of human notion of time, as the enormous duration of their action, which surpasses the existence of humanity, is reduced to a matter of years. It even speculates on the laws of statistics, as some temperature peak is effectively played out with a stage elevator that raises the author to his maximum. However, statistics eliminate such peak values using various methods, the simplest of which is the moving average method.

In fact, global warming is not measured in degrees, but in millimeters, indicating the rise in sea level due to the melting of glaciers. Such a rise is usually of the order of a few millimeters per year and is not capable of causing catastrophic processes. In addition, the accuracy of such measurements is difficult to achieve, since sea level fluctuations are comparable to the subsidence of the coastal land. If it is positive, it will

---

compensate for the sea level rise, but if it is negative, it will increase its value. It is known that the southern Black Sea coast is sinking by 2-3 mm per year, which has led to the sinking of river mouths and formation of estuaries (Burgas Lakes, Ropotamo, Devil's River, Veleka). However, this was not enough to compensate for the decrease in sea level from the cooling after the 14th century, thanks to the so-called "Mini-Ice Age", as a result of which it has dropped by 2 m.

After the end of this era, around the middle of the 19th century, even before the industrial era, a new global warming began (Robinson et al., 2007, Platt et al., 2017, etc.), which excludes human activity as a factor in this process. While preparing the article "Kamchatka – the Cold and the Heat of the Earth" Sinnyovsky et al. (2023) came across a surprising study from the 1970s, when there was no mention of global warming at all. Studying the glaciers of the Avacha group of volcanoes, which are located right next to the capital city Petropavlovsk-Kamchatsky, scientists from the Kamchatka branch of the USSR Academy of Sciences came to an interesting fact. Виноградов (1970) noted that the firn line (the line above which the snow does not melt in summer, but turns into granular ice-firn) is at 1800-2200 m, depending on whether it is NE or SW facing. The Avacha volcano is of the "somma" type, with a young cone (somma) in its caldera and an annular valley (atrium) between the young cone and the outer rim. Виноградов & Будников (1977) established that most glaciers fill the circular valleys "atrio" and, based on moraine deposits, concluded that in the middle of the nineteenth century the total area of glaciers in the Avacha group was 35.2 km<sup>2</sup>, and at the time of their study the glaciation was represented by 24 glaciers with a total area of 16.4 km<sup>2</sup>. Therefore, in a little over a hundred years, the area of glaciers has decreased by half.

Ordinary people are not experts and find it difficult to navigate the avalanche of information about global warming. They take the apocalyptic predictions for granted and believe that they must participate in the "salvation of future generations", according to the principle of sustainable development from "Our Common Future" of the Brundtland Commission (UN World Commission on Environment and Development. 1987) according to which "the present generation meets its needs without compromising the ability of future generations to meet their own needs". The truth is that man cannot influence such global processes and even if there is global warming, he cannot fight it in any way. Remember the ozone hole, because of which we had to feel guilty for using deodorants. At the beginning of the century, it was conveniently replaced by global warming.

---

## Conclusion

Two ancient human activities are associated with Pomorie Lake, representing an enduring cultural heritage for the region: the ancient Anchialo technology for salt extraction and the use of black bituminous mud, lye, hypersaline water and the marine climate for balneotherapy. The development of the Pomorie Geopark will create favorable conditions for combining traditional coastal and balneological tourism with specialized geotourism by developing geological routes presenting the geological history of the region, which is no less interesting than human history, in a language accessible to the general public.

The successful combination of the geological features of the region with its ecological, historical and cultural landmarks is in the spirit of the UNESCO Man and the Biosphere Programme, which unites natural and social sciences, economics and education to ensure the sustenance of humanity and the protection of natural ecosystems, and encourages the development of biosphere reserves - territories including terrestrial, marine and coastal ecosystems. Contrary to the widespread belief that these areas are intended only for the protection of rare and endangered species in an environment isolated from anthropogenic activity, biosphere reserves were created to promote the reconciliation of biological diversity with its sustainable use for the needs of the local population. This mission is the focus of the Pomorie Geopark with all the advantages and disadvantages accompanying innovative ideas for the development of a given region.

As the processes and phenomena related to the geological activity of the sea are among the main topics of the Pomorie Geopark, the other main goal of geo-education is to raise awareness among the population about the sea-level fluctuations over the last 11,700 years as a result of climate changes during the Holocene. The dissemination of knowledge about these changes aims to mitigate the anxiety instilled among the population by the apocalyptic predictions of ignorant oracles about the flooding of the ocean coast, which unfortunately also include some scientists with geological education.

The explanatory activity in the Pomorie Geopark should contrast the scientific facts of the recent geological past with the paranoia about a global apocalypse fanned by the media and the imputation of a sense of guilt among the population because of climate change. The futility of the so-called "fight against global warming" must be explained in a particularly clear and well-reasoned manner, which in its inefficiency can only be compared to "fight against volcanism". The fight against such geological phenomena is not and never will be within the power of man. The huge funds allocated to combat global warming can be used to mitigate the consequences of this phenomenon or for meaningful social activities that benefit people and not be poured into pseudo-scientific projects to prevent the phenomenon itself and transformed into the accounts of various "environmental" organizations.

The mission of the Geopark is to popularize the truth about global climate change as a natural phenomenon among all age groups and at all information levels, including among decision-makers in ministries and departments, on whom the preservation of geological phenomena along the Black Sea coast depends, with the message that many people have died from hunger and wars, but no one has died from global climate change in the historical past. On the contrary, the greatness of the First Bulgarian State coincides with the Nymphaean warming - its creation in the 7th century, the saving of Europe from the invasion of the Saracens by Tervel in the 8th century, the creation of Cyrillic and the adoption of Christianity in the Golden 9th Century, and the brilliant military victories of Simeon I the Great in the 10th century, making Bulgaria an empire on three seas.

## References

- Архангельский, А. Д., Н. М. Страхов. 1938. Геологическое строение и история развития Черного моря. (Геологическое строение и эволюция Черного моря). М.-Л., Геол. Инст. АН СССР, 236 с.
- Блаватский, В. Д. 1961. Подводные раскопки в Фанагории в 1959 г. – *Сов. археология*, 1, 277-279.
- Благоволин, Н. С., А. Н. Щеглов. 1968. Колебания уровня Черного моря в историческое время по данным археолого-геоморфологических исследований в Юго-Западном Крыму. – *Изв. АН СССР, Сер. геогр.*, 2, 49-58.
- Борисов, И. 1965. Петрографски изучавания на магматитите северно от гр. Бургас и сравнителна петрохимична характеристика на горнокредните вулкани в България. – *Год. Соф. унив.*, 58, 1; 197-231.
- Виноградов В. Н. 1970. Современное оледенение Авачинской группы вулканов. – *Вопросы Географии Камчатки*, 6, 51-61.
- Виноградов В. Н., А. Е. Будников. 1977. Динамика ледников Авачинской группы вулканов в последнее столетие и черты их режима. – *Вопросы Географии Камчатки*, 7, 26-30.
- Златарски, Г. 1905. Сенонските образувания в Източния и отчасти в Централния Балкан и южно от тая планина. – *Пер. сп. Бълг. кн. д-во*, 66, 113-125.
- Канев, Д. 1988. Към тайните на релефа в България. С., Народна просвета, 150 с.
- Попов, В., К. Мишев. 1974. *Геоморфология на българското черноморско крайбрежие и шелф*. С., Изд. БАН, 267 с.
- Синьовски, Д. 2023. Оценка на фосилни находища за целите на геотуризма в България. – *Сп. Бълг. геол. д-во*, 84, 2, 3-24.
- Синьовски, Д., В. Желев, М. Антонов, С. Джуранов, З. Илиев, Д. Вангелов, Г. Айданлийски, П. Петров, Х. Василев. 2002. Метод за оценка на геоложки феномени. – II Международна Конференция SGEM, Варна, 25-33.
- Сорокин, В. М., П. Н. Куприн. 2007. О характере подъема уровня Черного моря, в голоцене. – *Вестн. Моск. Ун-та*, 4, Геол., 5, 40-46.
- Тончева, Г. 1964. Потънали пристанища. ДИ Варна, 80 с.
- Федоров, П.В. 1956. О современной эпохе в геологической истории Черного моря. – *Докл. Акад. Наук СССР*, 110, 5, 839-841.
- Федоров, П.В. 1959. О колебаниях уровня Черного моря в послеледниковое время. – *Докл. Акад. Наук СССР*, 124, 5, 1127-1129.
- Aksu, A.E., R.N. Hiscott, D. Yaşar, F.I. İşler, S. Marsh. 2002. Seismic stratigraphy of Late Quaternary deposits from the southwestern Black Sea shelf: evidence for non-catastrophic variations in sea-level during the last ~10000 years. – *Marine Geology*, 190, 61–94.
- Alvarez, L. W., W. Alvarez, F. Asaro, H. V. Michel. 1980. Extraterrestrial Cause for the Cretaceous/Tertiary Extinction. – *Science*, 208, 1095-1108.
- Balabanov, I. P. 2007. Holocene sea-level changes of the Black Sea. In: Yanko-Hombach, V., A. S. Gilbert, N. Panin, P. M. Dolukhanov (Eds.) *The Black Sea Flood Question: Changes in Coastline, Climate and Human Settlement*. Dordrecht, Springer, The Netherlands, 711-730.
- Baltakova, A. 2023. Coastal foredune enlargement – a sign of sea-level change? An example from the Kavatsite beach-dune system. – *Rev. Bulg. Geol. Soc.*, 84, 3, 329-322.
- Guggenheim, D., A. Gore. 2006. *An Inconvenient Truth*. Participant Productions, Distr. Paramount Classics (Paramount Pictures).
- Hiscott, R. N., A. E. Aksu, P. J. Mudie, F. Marret, T. Abrajano, M. A. Kaminski, J. Evans, A. İ. Çakiroğlu, D. Yaşar. 2007. A gradual drowning of the southwestern Black Sea shelf: Evidence for a progressive rather than abrupt Holocene reconnection with the eastern Mediterranean Sea through the Marmara Sea Gateway. – *Quaternary International*, 167–168, 19-34.
- Kuprin, P. N., V. M. Sorokin. 2007. On the post-glacial changes in the level of the Black Sea. – In: Yanko-Hombach, V., A. S. Gilbert, N. Panin, P. M. Dolukhanov (Eds.) *The Black Sea Flood Question: Changes in Coastline, Climate and Human Settlement*. Dordrecht, Springer, 205–220.
- Larchenkov, E., S. Kadurin. 2011. Paleogeography of the Pontic Lowland and northwestern Black Sea shelf for the past 25 k.y. In: Buynevich, I. V., V. Yanko-Hombach, A. S. Gilbert, R. E. Martin (Eds.) *Geology and geoarcheology of the Black Sea Region*, 71-84.
- Lidgard, S., A. C. Love. 2021. The living fossil concept: reply to Turner. – *Biology and Philosophy*, 36, 13, 1-16, <https://doi.org/10.1007/s10539-021-09789-z>.
- Milanković, M. 1941. Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitproblem. – *König. Serb. Acad. Pos. Izd.*, 132, Prirod.-Mat. Sp., 33, Belgrade, 633 p.
- Platt, E., M. Haber, M. Bou Dagher-Kharrat, B. Douaihy, G. Khazen, M. A. Bonab, A. Salloum, F. Mouzaya, D. Luiselli, C. Tyler-Smith, C. Renfrew, E. Matisoo-Smith, P. A. Zalloua. 2017. Mapping Post-Glacial expansions: The Peopling of Southwest Asia. – *Sci. Rep.* 7, 40338; doi: 10.1038/srep40338.

- Pomorie Lake. 2013. Website of Green Balkan's Project "Urgent measures for restoration and conservation of species and habitats of European significance within Pomorie Lake complex of protected natural areas". [https://greenbalkans.org/pomorielake/indexdetails.php?menu\\_id=34&c\\_lang=1](https://greenbalkans.org/pomorielake/indexdetails.php?menu_id=34&c_lang=1).
- Ryan, W. B. F. 2007. Status of the Black Sea flood hypothesis. – In: Yanko-Hombach, V., A. S. Gilbert, N. Panin, P. M. Dolukhanov (Eds.). *The Black Sea Flood Question: Changes in Coastline, Climate and Human Settlement*. Dordrecht, Springer, 63–88.
- Ryan, W.B.F., W. C. Pitman III. 1998. *Noah's Flood: The New Scientific Discoveries about the Event that Changed History*. New York, Simon & Schuster, 320 pp.
- Ryan, W.B.F., W. C. Pitman III, C. O. Major, K. Shimkus, V. Moskalenko, G. A. Jones, P. Dimitrov, N. Görür, M. Sakiç, H. Yüce. 1997a. An abrupt drowning of the Black Sea shelf. – *Marine Geol.*, 138, 119–126.
- Ryan, W.B.F., W. C. Pitman III, C. O. Major, K. Shimkus, V. Moskalenko, G. A. Jones, P. Dimitrov, N. Görür, M. Sakiç, H. Yüce. 1997b. An abrupt drowning of the Black Sea shelf at 7.5 kyr BP. – *Geo-Eco-Marina*, 2, 115–126.
- Sharples, C. 1993. *A Methodology for Identification of Significant Landforms and Geological Sites for Geoconservation Purposes*. A Report to: Forestry Commission Tasmania, 31 p.
- Sharples C. 1995. Geoconservation in forest management-principles and procedures. – Forestry Tasmania, Tasforest, Hobart, 7, 37-50 <https://www.researchgate.net/publication/291701182>.
- Sharples C. 2002. Concepts and principles of geoconservation. Tasmanian Parks & Wildlife Service website, Version 3, 79 pp. <https://dpiwwe.tas.gov.au/Documents/geoconservation.pdf>.
- Sinnyovsky, D., 2023. Evaluation Features of Fossil and Coastal Geosites: Selecting Assessment Criteria for Geotourism Purposes. – *C. R. de l'Acad. bulg. Sci.*, 76, 2, 247-255.
- Sinnyovsky, D., 2024. Evaluation of geological sites in a park environment for the needs of the Bulgarian geoparks, nature parks, and national parks. – *Rev. Bulg. Geol. Soc.*, 85, 1, 11-31.
- Sinnyovsky, D., N. Kalutskova, N. Dronin, D. Sinnyovska, A. Medvedev, N. Telnova. 2019. Concepts of geoparks establishment in Bulgaria and their geothermal resources. - IOP Conf. Series: Earth Environ. Sci., 367, 012006, 1-15.
- Sinnyovsky D., D. Sachkov, I. Tsvetkova, N. Atanasova. 2020. Geomorphosite Characterization Method for the Purpose of an Aspiring Geopark Application Dossier on the Example of Maritsa Cirque Complex in Geopark Rila, Rila Mountain, SW Bulgaria. – *Geoheritage*, 12, 1, (26) 1-17 doi.s12371-020-00451-w.
- Sinnyovsky, D., A. Gorbach, V. Gorbach, D. Sinnyovska. 2023. Kamchatka—the Cold and the Heat of the Earth. – *Geoheritage*, 15, 115, 1-33, <https://doi.org/10.1007/s12371-023-00885-y>.
- UNESCO General Conference. 2015. Statutes of the International Geoscience and Geoparks Programme (IGGP). Document 38 C/14, Paris 14 September 2015. Annex I, Draft Statutes of the International Geoscience and Geoparks Programme, 1-6; Annex II, Draft Proposed Operational Guidelines for UNESCO Global Geoparks, 1-10 <https://unesdoc.unesco.org/ark:/48223/pf0000234539>.
- UN World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press, Business and Economics, 400 p.
- Wimbledon W.A., M.J. Benton, R.E. Bevins, G.P. Black, D.R. Bridgland, C.G. Cleal, R.G. Cooper, V.J. May. 1995. The development of a methodology for the selection of British geological sites for conservation: part I, *Mod. Geol.*, 20, 159–202.
- Yanko-Hombach, V. 2007. Controversy over Noah's flood in the Black Sea: geological and foraminiferal evidence from the shelf. – In: Yanko-Hombach, V., A. S. Gilbert, N. Panin, P. M. Dolukhanov (Eds.). *The Black Sea Flood Question: Changes in Coastline, Climate and Human Settlement*. Dordrecht, Springer, 149–203.
- Yanko-Hombach, V., A. Tschepaliga. 2003. Geology of a catastrophe—the when and where of the Black Sea Flood. Abstracts XVI INQUA Congress (23–30 July 2003, Reno, Nevada), Session 84, p. 224.
- Yanko-Hombach, V., A. S. Gilbert, N. Panin, P. M. Dolukhanov (Eds.). 2007. *The Black Sea Flood Question: Changes in Coastline, Climate and Human Settlement*. Dordrecht, Springer, 971 pp.
- Yanko-Hombach, V., P. J. Mudie, S. Kadurin, E. Larchenkov. 2013. Holocene marine transgressionms in the Black Sea: New evidence from the northwestern Black Sea shelf. – *Quaternary International*, pp. 1-19. <http://www.sciencedirect.com/science/article/pii/S10406182130044266>.

Фондови материали:

- Желев, В., Д. Синьовски. 2024. Алкалните вулкани от северната част на Бургаския район. Отчет по Проект № BG06RDNP001-19.607-0010-C01 "ROADS: Пътища към устойчив геотуризм", 17 с.



This publication was created with the financial support of the European Union through the European Agricultural Fund for Rural Development in implementation of Contract No. RD 50-4/10.01.2024 for the project "ROADS: Roads to Sustainable Geotourism" concluded with the Ministry of Agriculture of the Republic of Bulgaria under procedure No. BG06RDNP001-19.607 for the selection of projects for intra-territorial and transnational cooperation under sub-measure 19.3 "Preparation and implementation of cooperation activities with LIG" of measure 19 "CLLD" of the Rural Development Programme for the period 2014-2020